

















**BULLETIN**  
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# CONTENTS OF VOLUME XXVIII.

	PAGE.
Title-page.....	i
Officers and Trustees.....	iii
Scientific Staff.....	iv
Contents.....	vii
Dates of Publication of Authors' Separates.....	viii
List of Illustrations.....	ix
List of New Names of Higher Groups, Genera, Species and Subspecies.....	xii
ART. I.—The Black Bear of Labrador. By J. A. ALLEN.....	1
II.—Mammals from the Athabaska-Mackenzie Region of Canada. By J. A. ALLEN.....	7
III.—Mammals from Palawan Island, Philippine Islands. By J. A. ALLEN.....	13
IV.—Description of a Skull and some Vertebrae of the Fossil Cetacean <i>Diochotichus vanbenedeni</i> from Santa Cruz, Patagonia. By FREDERICK W. TRUE. (Plates I–V).....	19
V.—On the Skull of <i>Apternodus</i> and the Skeleton of a New Artiodactyl. By W. D. MATTHEW. (Plate VI, and five text figures).....	33
VI.—On the Osteology and Relationships of <i>Paramys</i> , and the Affinities of the Ischyromyidae. By W. D. MATTHEW. (Nineteen text figures.).....	43
VII.—On some Orthoptera from Porto Rico, Culebra and Vieques Is- lands. By JAMES A. G. REHN. (One text figure.).....	73
VIII.—Some Parasitic Hymenoptera from Vera Cruz, Mexico. By CHARLES T. BRUES. (One text figure.).....	79
IX.—Additional Mammals from Nicaragua. By J. A. ALLEN.....	87
X.—The North American Species of <i>Neuroterus</i> and their Galls. By WILLIAM BEUTENMÜLLER. (Plates VIII–XIII.).....	117
XI.—The North American Species of <i>Aylax</i> and their Galls. By WILLIAM BEUTENMÜLLER. (Plate XIV.).....	137
XII.—Mammals from the Caura District of Venezuela, with Description of a new species of <i>Chrotopterus</i> . By J. A. ALLEN.....	145
XIII.—On the Genus <i>Presbytis</i> Esch., and 'Le Tarsier' Buffon, with Descriptions of two new species of <i>Tarsius</i> . By D. G. ELLIOT	151
XIV.—A note on <i>Siphostoma pelagicum</i> (Osbeck). By JOHN TREADWELL NICHOLS.....	155
XV.—A Note on the identity of <i>Caranx forsteri</i> Cuvier & Valenciennes. By JOHN TREADWELL NICHOLS.....	159
XVI.—On two new Blennys from Florida. By JOHN TREADWELL NICHOLS.....	161
XVII.—New or Little Known Reptiles and Amphibians from the Permian(?) of Texas. By E. C. CASE. (Ten text figures.).....	163
XVIII.—The Skeleton of <i>Pacilospondylus francisi</i> , a new Genus and Species of Pelycosauria. By E. C. CASE. (Three text figures.).....	183

	PAGE
XIX.—Description of a Skeleton of <i>Dimetrodon incisivus</i> Cope. By E. C. CASE. (Plates XV–XIX, and five text figures.).....	189
XX.—A Comparison of the Permian Reptiles of North America with those of South Africa. By R. BROOM. (Twenty text figures.)	197
XXI.—Tertiary Faunal Horizons in the Wind River Basin, Wyoming, with Descriptions of new Eocene Mammals. By WALTER GRANGER. (Plates XX–XXIII, and six text figures.).....	235
XXII.—The North American species of <i>Aulacidea</i> and their Galls. By WILLIAM BEUTENMÜLLER. (Plates XXIV–XXVI.).....	253
XXIII.—Three New Genera of Myrmicine Ants from Tropical America. By WILLIAM MORTON WHEELER. (Three text figures.).....	259
XXIV.—The Cretaceous Ojo Alamo Beds of New Mexico with Description of the New Dinosaur Genus <i>Kritosaurus</i> . By BARNUM BROWN. (Plates XXVII–XXIX, and seven text figures.).....	267
XXV.—Fossil Insects and a Crustacean from Florissant, Colorado. By T. D. A. COCKERELL. (Four text figures.).....	275
XXVI.—The Phylogeny of the Felidæ. By W. D. MATTHEW. (Fifteen text figures.).....	289
XXVII.—Collation of Brisson's Genera of Birds with those of Linnæus. By J. A. ALLEN. ....	317
XXVIII.—Observations on the Habits and Distribution of Certain Fishes taken on the Coast of North Carolina. By RUSSELL J. COLES	337

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## LIST OF ILLUSTRATIONS.

## Plates.

- I.—Skull of *Diochotichus vanbenedeni*, superior aspect.  
 II.—Same skull, inferior aspect.  
 III.—Skull, lateral aspect, and earbones of *D. vanbenedeni*.  
 IV.—Skull, posterior aspect, and ribs of *D. vanbenedeni*.  
 V.—Vertebrae of *Diochotichus vanbenedeni*.  
 VI.—*Apternodus mediævus*, skull, top, side and under views.  
 VII.—(There is no plate VII, owing to an error in numeration.)  
 VIII.—Galls of *Neuroterus batatus*.  
 IX.—Galls of *Neuroterus noxiosus*.  
 X.—Galls of *Neuroterus niger*, *papillatus*, *consimilis*, *vesiculus* and *affinis*.  
 XI.—Galls of *Neuroterus floccosus*, *minutissimus*, *verrucarum*, *howertoni*, *laurifoliae*, *saltatorius*, *cockerelli*, *rileyi*.  
 XII.—Galls of *Neuroterus tectus*, *minutus*, *distortus*, *pallidus*, *vernus*, *pallipes*, *longipennis*, *clarkeæ*.  
 XIII.—Galls of *Neuroterus fragilis*, *irregularis*, *majalis*, *umbilicatus*, *obtusilobæ*.  
 XIV.—Galls of *Aylax glechomæ*, *leavenworthi*, *laciniatus*, *rufus*, *taraxaci*, *chrysothamni*, *pisum*.  
 XV.—*Dimetrodon incisivus*, lateral aspect of skull.  
 XVI.—*D. incisivus*, superior aspect of skull.  
 XVII.—*D. incisivus*, inferior aspect of skull.  
 XVIII.—*D. incisivus*, posterior and anterior aspects of skull.  
 XIX.—*D. incisivus*, mounted skeleton.  
 XX.—Escarpment of the Beaver Divide at Green Cove, near Hailey, Wyoming, looking south.  
 XXI.—View looking southwest along the northern face of the Beaver Divide from Wagon-bed Spring.  
 XXII.—Fig. 1. Exposure at Wagon-bed Spring, Beaver Divide.  
           Fig. 2. Lambdotherium zone, Wind River beds.  
 XXIII.—Fig. 1. Lambdotherium zone, Wind River beds.  
           Fig. 2. Cottonwood Creek exposures, looking north.  
 XXIV.—Galls of *Aulacidea tumida*.  
 XXV.—Galls of *Aulacidea podagræ* and *bicolor*.  
 XXVI.—Galls of *Aulacidea nabali*.  
 XXVII.—Cretaceous, near Ojo Alamo, New Mexico.  
 XXVIII.—Type skull of *Kritosaurus navajovius*.  
 XXIX.—Inner view of lower jaw of *Kritosaurus navajovius*.

## Text Figures.

	PAGE
<i>Eotylopus reedi</i> , skull and jaws.....	37
“ “ upper teeth.....	38
“ “ lower teeth.....	38

	PAGE
<i>Eotylopus reedi</i> fore limb.....	39
“ “ hind limb.....	40
<i>Paramys delicatus</i> , skull and lower jaw.....	45
“ “ under view of skull.....	46
“ “ top view of skull.....	47
“ <i>robustus</i> , fore foot.....	48
“ “ hind foot.....	49
“ <i>delicatus</i> , restoration of skeleton.....	53
“ <i>robustus</i> , lower jaw.....	54
“ ( <i>Ischyrotomus</i> ) <i>petersoni</i> , skull and lower jaws.....	55
“ “ “ fore foot.....	56
“ ( <i>Leptotomus</i> ) <i>grangeri</i> , lower jaw, superior and external views.....	57
“ <i>grangeri</i> and <i>P. petersoni</i> , claw phalanges of fore foot, dorsal and lateral views.....	57
“ ( <i>Leptotomus</i> ) <i>grangeri</i> , fore foot.....	59
<i>Sciuravus nitidus</i> , skull and lower jaw.....	59
“ “ under view of skull.....	60
“ “ top view of skull.....	60
<i>Ischyromys typus</i> , skull.....	61
“ “ under view of skull.....	62
“ “ top view of skull.....	62
Phylogeny of North American Fossil Rodents.....	67
<i>Epilampra wheeleri</i> n. sp., dorsal view of type.....	74
<i>Metanopedius sicarius</i> sp. nov., ♀, antenna.....	80
Chart of North Atlantic showing points of capture of <i>Siphostoma pelagicum</i> and <i>Pterophryne histrio</i> .....	156
<i>Diadectes phaseolinus</i> , superior aspect of skull.....	164
“ “ posterior and lateral aspects of skull.....	165
“ “ inferior aspect of skull.....	166
“ “ transverse section of the skull at center of orbits and a longitudinal section of the skull.....	168
“ “ reconstruction of the skeleton.....	170
“ “ “ “ “ “ front view.....	173
Type vertebræ, upper row, <i>Diasparactus zenos</i> ; lower row, <i>Diadectes maximus</i> .....	175
<i>Gymnarthrus willoughbyi</i> , type skull, lateral and superior aspects.....	178
<i>Aspidosaurus glascocci</i> , type vertebræ.....	180
<i>Tersomius texensis</i> , type skull.....	181
<i>Pæcilospondylus francisi</i> , portions of the type.....	184
“ “ superior and lateral aspects of type.....	186
“ “ right hind limb of type, external or dorsal view.....	187
<i>Dimetrodon incisivus</i> , stapes.....	190
“ “ inferior aspect of skull.....	191
“ “ inner view of pterygoquadrate region.....	192
“ “ posterior aspect of skull.....	193
<i>Captorhinus angusticeps</i> , posterior aspect of skull.....	194
<i>Pareiasaurus</i> , under view of skull.....	202
<i>Procolophon trigoniceps</i> Owen, under view of skull.....	204
<i>Galepus jouberti</i> Broom, skull.....	205

	PAGE
<i>Delphinognathus conocephalus</i> Seeley, skull.....	206
<i>Scylacosaurus sclateri</i> Broom, skull.....	208
“ “ “ under side of skull.....	209
<i>Aloposaurus gracilis</i> Broom, skull.....	210
<i>Scaloposaurus constrictus</i> Owen, skull.....	210
<i>Oudenodon gracilis</i> Broom, skull.....	212
<i>Cistecephalus microrhinus</i> Owen, skull.....	213
<i>Diadectes phaseolinus</i> Cope, skull.....	216
<i>Diadectes</i> , under view of skull.....	217
<i>Pariotichus angusticeps</i> Cope, skull.....	218
“ “ “ under view of skull.....	218
<i>Gymnarthrus</i> Case, skull.....	219
<i>Edaphosaurus pogonias</i> Cope, skull.....	222
“ “ “ top of skull.....	223
“ “ “ lower view of skull.....	224
<i>Dimetrodon incisivus</i> Cope, skull.....	225
“ “ “ under side of skull.....	227
Generalized section of the Tertiary of the Beaver Divide.....	238
Generalized section of the Lower Eocene in the vicinity of Lost Cabin.....	244
Sketch map of the Wind River Basin.....	246
<i>Camelodon arapahovius</i> , lower jaw, superior and internal views.....	248
<i>Shoshonius cooperi</i> , upper jaw, external and crown views.....	249
<i>Parictops multicusps</i> , lower jaw, superior and external views.....	251
<i>Nesomyrmex clavipilis</i> sp. nov.; <i>a</i> , female in profile; <i>b</i> , head; <i>c</i> , thorax of same seen from above.....	260
<i>Apsychomyrmex myops</i> sp. nov.; <i>a</i> , worker in profile; <i>b</i> , head of same from above; <i>c</i> , antenna.....	262
<i>Lachnomyrmex scrobiculatus</i> sp. nov.; <i>a</i> , worker in profile; <i>b</i> , head of same from above; <i>c</i> , antenna.....	264
Ceratopsian horn.....	269
<i>Kritosaurus navajovius</i> left quadrato-jugal.....	271
“ “ “ type, left quadrate, rear view.....	271
“ “ “ prementary, top view.....	272
“ “ “ “ side view.....	272
“ “ “ inferior view of lower jaw.....	273
“ “ “ type, lingual surface of a lower tooth.....	274
<i>Indusia cypridis</i> sp. nov., with <i>Cypris florissantensis</i> , sp. nov.....	276
<i>Bittacomorpha miocenica</i> sp. nov.....	281
<i>Hirmoneurites willistoni</i> sp. nov.....	283
<i>Nemotelus prisculus</i> sp. nov.....	286
Carnassials of Felines and Machærodonts.....	291
Feline series, upper jaw.....	292
Machærodont series, upper jaw.....	293
Skulls of Felines and Machærodonts.....	295
Fifth cervical vertebra in Felines and Machærodonts.....	297
Basicranial region in Felines and Machærodonts.....	299
Feline series, lower jaw.....	300
Machærodont series, lower jaw.....	301
<i>Smilodon</i> and <i>Felis</i> . Diagram to show the relations of certain muscles.....	303

	PAGE
<i>Dinictis squalidens</i> , skull and jaws, one half natural size.....	309
<i>Nimravus gomphodus</i> , skull and jaws, one half natural size.....	311
<i>Felis concolor</i> , skull and jaws, one half natural size.....	312
<i>Hoplophoneus primævus</i> , skull and jaws, one half natural size.....	313
<i>Machærodus palmidens</i> , skull and jaws, half natural size.....	314
<i>Smilodon californicus</i> , skull and jaws, one third natural size.....	315

## LIST OF NEW NAMES OF HIGHER GROUPS, GENERA, SPECIES AND SUBSPECIES.

### SUBORDER.

	PAGE
<i>Gymnarthria</i> Case.....	177

### FAMILIES AND SUBFAMILIES.

<i>Apternodontinæ</i> (subfam. of <i>Centetidæ</i> ) Matthew.....	35
<i>Gymnarthridæ</i> Case.....	177
<i>Aspidosauridæ</i> Case.....	179

### GENERA AND SUBGENERA.

<i>Eotylopus</i> Matthew.....	36
<i>Leptotomus</i> (subgen. of <i>Paramys</i> ) Matthew.....	50
<i>Ischyrotomus</i> (subgen. of <i>Paramys</i> ) Matthew.....	50
<i>Titanotheriomys</i> (subgen. of <i>Ischyromys</i> ) Matthew.....	63
<i>Metanopedias</i> Brues.....	79
<i>Anusioptera</i> Brues.....	83
<i>Diasparactus</i> Case.....	174
<i>Gymnarthrus</i> Case.....	177
<i>Tersomius</i> Case.....	180
<i>Pæcilospondylus</i> Case.....	185
<i>Camelodon</i> Granger.....	248
<i>Shoshonius</i> Granger.....	249
<i>Parictops</i> Granger.....	250
<i>Nesomyrmex</i> Wheeler.....	259
<i>Apsychomyrmex</i> Wheeler.....	261
<i>Lachnomyrmex</i> Wheeler.....	263
<i>Agræcomyrmex</i> Wheeler.....	265
<i>Kritosaurus</i> Brown.....	269
<i>Hecatasaurus</i> Brown.....	273
<i>Hirmoneurites</i> Cockerell.....	283
<i>Nemestrinopsis</i> Cockerell.....	285

## SPECIES AND SUBSPECIES.

	PAGE
<i>Ursus americanus kenaiensis</i> Allen.....	6
“ “ <i>perniger</i> Allen.....	115
<i>Mus luteiventris</i> Allen.....	14
<i>Arctictis whitei</i> Allen.....	15
<i>Mungos palawanus</i> Allen.....	17
<i>Eotylopus reedi</i> Matthew.....	36
<i>Paramys (Ischyrotomus) petersoni</i> Matthew.....	56
<i>Paramys (Leptotomus) grangeri</i> Matthew.....	57
<i>Epilampra wheeleri</i> Rehn.....	73
<i>Metanopedias sicarius</i> Brues.....	79
<i>Idris quadrispinosus</i> Brues.....	80
<i>Opisthacantha striativentris</i> Brues.....	81
<i>Anusioplera aureocincta</i> Brues.....	83
<i>Ænasilus cæruleus</i> Brues.....	84
<i>Odocoileus rothschildi chiriquensis</i> Allen.....	95
<i>Macrogeomys matagalpæ</i> Allen.....	97
<i>Oryzomys richardsoni</i> Allen.....	99
<i>Oryzomys (Oligoryzomys) nicaraguæ</i> Allen.....	100
<i>Conepatus nicaraguæ</i> Allen.....	106
<i>Neuroterus papillosus</i> Beutenmüller.....	121
<i>Neuroterus cockerelli</i> Beutenmüller.....	125
<i>Neuroterus clarkeæ</i> Beutenmüller.....	132
<i>Chrotopterus carrikeri</i> Allen.....	147
<i>Tarsius saltator</i> Elliot.....	152
<i>Tarsius borneanus</i> Elliot.....	153
<i>Stathmonotus tekla</i> Nichols.....	161
<i>Blennius fabbri</i> Nichols.....	161
<i>Diadectes maximus</i> Case.....	174
<i>Diasparactus zenos</i> Case.....	174
<i>Ctenosaurus rugosus</i> Case.....	176
<i>Gymnarthrus willoughbyi</i> Case.....	177
<i>Aspidosaurus glascocki</i> Case.....	179
<i>Tersomius texensis</i> Case.....	180
<i>Trimerorhachis alleni</i> Case.....	181
<i>Pæilospondylus francisi</i> Case.....	183
<i>Galepus jouberti</i> Broom.....	204
<i>Camelodon arapahovius</i> Granger.....	248
<i>Shoshonius cooperi</i> Granger.....	249
<i>Parictops multicuspis</i> Granger.....	250
<i>Nesomyrmex clavipilis</i> Wheeler.....	259
<i>Apsychomyrmex myops</i> Wheeler.....	261
<i>Lachnomyrmex scrobiculatus</i> Wheeler.....	263
<i>Kritosaurus navajovius</i> Brown.....	269
<i>Derobrochus typharum</i> Cockerell.....	275
<i>Indusia cypridis</i> Cockerell.....	276
<i>Eriocampa pristina</i> Cockerell.....	276
<i>Geotiphia sternbergi</i> Cockerell.....	277

	PAGE
<i>Geotiphia halictina</i> Cockerell.....	279
<i>Selandria sapindi</i> Cockerell.....	279
<i>Bitlacomorpha miocenica</i> Cockerell.....	280
<i>Tipula needhami</i> Cockerell.....	281
<i>Taracticus contusus</i> Cockerell.....	282
<i>Hirnoneurites willistoni</i> Cockerell.....	283
<i>Nemotelus prisculus</i> Cockerell.....	286
<i>Pachysystropus condemnatus</i> Cockerell.....	287
<i>Cypris florissantensis</i> Cockerell.....	288

## ERRATA.

- Page 6, line 16, for **Ursus americanus kenaiensis** read **Ursus americanus perniger**; see explanation, page 115.
- “ 13, “ 5, for *Muntiacus* read *Tragulus*.
- “ 13, “ 20, for **Muntiacus** read **Tragulus**.
- “ 15, “ 28, for **Arctitis** read **Arctictis**.
- “ 16, “ 28, for *Arctitis* read *Arctictis*.
- “ 80, Fig. 1, for *Metanopedius* read *Metanopedias*.
- “ 94, line 39, for *angulatus* read *angulatus*.
- “ 110, “ 10, for **olivaceus** read **olivacea**.
- “ 112, “ 9, for “without definite locality, the label having been detached in shipment” read “Vijagua, March, 1909, according to Mr. Richardson’s letter of May 4, 1910.”
- “ 178, Fig. 8, for *willoughbi* read *willoughbyi*.
- Plate X, for *nigrum* read *niger*.

**Addendum to Article XX, Volume XXVIII, pp. 197–234, on  
‘A Comparison of the Permian Reptiles of North America with those of  
South Africa,’ by R. Broom, M. D.**

*Note.*—24 June, 1910. Hitherto the only evidence we have had of the digital formula of Therocephalians has been that obtained from the manus of *Theriodesmus phylarchus* Seeley and here there has been some uncertainty as to the number of phalanges. Within the last few days I have received from the Rev. Mr. Whaits the very fragmentary remains of two small skeletons which are almost certainly Therocephalian. Although most of the toe bones are detached, one toe, manifestly a 4th, has the bones in position. When the *Theriodesmus* foot is viewed in the light of the new finds it becomes manifest that the formula is 2, 3, 4, 5, 3, the 2nd phalanx of the 3rd digit and the 2nd and 3rd of the 4th being extremely short. In the Dromosauria, Anomodontia and Cynodontia, the formula is 2, 3, 3, 3, 3. If the Dinocephalia have the same formula as the Therocephalia the difference between them and the Pelycosaurs is probably not much greater than between a tapir and a cat — a matter of tooth, skull and limb specialization.

R. BROOM.







# BULLETIN

OF THE

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### Article I.—THE BLACK BEAR OF LABRADOR.

BY J. A. ALLEN.

In 1898 Mr. Outram Bangs<sup>1</sup> described the Black Bear of Labrador as *Ursus americanus sornborgeri*, on the basis of three young adult skulls, apparently all females. The type (No. 7411, coll. E. A. and O. Bangs) was from Okak, the others one each from Hopedale and "Maine" (=Nain). "External characters unknown."

My attention was recently strongly drawn to this alleged form of *Ursus* from Labrador by a skull of a bear killed near Nain by Mr. L. S. Quackenbush, August 8, 1905, and kindly loaned to the American Museum for examination. In a letter Mr. Quackenbush states: "The bear was a male and measured only 49 inches in a straight line from nose to tail; the hind foot from heel to end of longest toe (without claw) was 8 inches long. The fur was black on all parts of the body excepting a small patch of ashy gray over the maxillary region on each side of the snout."

The small size of this skull, and especially the small size of the teeth, coupled with the fact that it was stated to be a *male*, and obviously old, seemed to indicate that *Ursus americanus sornborgeri* was a bear of small size and weak dentition. On applying to Mr. Bangs for the loan of his original material — three skulls — of this subspecies he not only kindly sent me these but also 15 other skulls collected at different points by Mr. Sornborger during the years 1898 and 1900. To my amazement, this series included skulls equalling in size any in a large series from other localities within the United States, and with teeth of the usual size. Indeed, male skulls of Black Bears from Arizona, Oregon, and other parts of the United States, were indistinguishable in any feature from some of the large Labrador skulls.

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<sup>1</sup> American Nat., XXXII, July, 1898, pp. 500, 501.



Unfortunately the sex is indicated for very few of the skulls available in this connection for examination, and in the subjoined table of measurements the Labrador specimens are arranged in the order of size, from left to right, and the sex is provisionally indicated on the basis of size and general appearance of the skull. The total length is the basis of the arrangement, with the exception of a single young skull, obviously male, which is placed at the extreme right of the old males. This skull retains the milk canines and the outer milk incisors, and the last molar, both above and below, had not cut the gum; yet  $p^4$  and  $m^1$ , and  $p_4-m_2$ , are a little above the maximum size for the rest of the series of skulls.

Beginning at the left of the table the first nine skulls are almost unquestionably female; the first is the youngest, but has all of the teeth fully developed, and was undoubtedly sexually mature. The next five, although older as well as larger, are still young adults, while the five following are middle-aged adults. Although one of them (No. 2742 in the table) is sexed by a trustworthy collector as male, in general size and in the size of the teeth it is indistinguishable from the others provisionally indicated as female. (It is much older than the next one in the series (No. 7353), but is smaller and has much smaller teeth.) The next three are middle-aged adults, which grade in size up to No. 7352, a young adult skull, presumably male; and this falls little below the size of the next four, which steadily increase in size to the maximum, although only No. 7360 is really an *old* skull, as shown by the obliteration of sutures and the greatly worn teeth; it is absolutely indeterminate as to sex. It is small for a male, but very large for a female.

In most species of *Ursus* the male is supposed to average much larger than the female, with a much broader rostrum and larger teeth, especially the canines, and it is generally considered safe to distinguish the sexes, in the case of skulls unmarked for sex, on this basis. In this series of bear skulls from Labrador, however, I find it quite impossible satisfactorily to discriminate between males and females. Referring again to the table of measurements, and beginning at the left, the second skull (No. 7365) is considerably older than the first (No. 7364), and is also larger in general dimensions, but its tooththrow is shorter and the individual teeth are much smaller than in the first, in which the teeth are approximately of the size of those of the average for the series. The largest teeth are not restricted to the largest skulls.

Much of the differentiation shown in the size of the skull in this series is obviously due to age, but much also to individual variation, and a large but unknown amount to sex. Individual variation is especially manifest in the size and form of  $m^2$ , which varies greatly in skulls otherwise similar in general size and form. This tooth varies in length, in specimens that seem un-

Measurements of Skulls of *Ursus americanus* and *U. a. kenaiensis*.

Locality	Ft Klamath, Oregon.		Mogollon Mts., Ariz.		?	Duluth, Minn.				Near Homer, Kenai Pen., Alaska.							
	1997	1998	1999	16213		48	47	52	49	51	34966	16708	17790	17792	16706	16705	17791
Number																	
Sex																	
Total length	304	298	277	278	277	304	264	285	285	296	250	253	255	274	277		292
Condylolbasal length	287	280	265	265	260	289	255	260	268	275	—	240	246	262	260		267
Palatal length	141	141	140	132	133	133	130	136	135	143	129	126	126	133	133		140
Zygomatic breadth	170	185	150	145	153	186	155	182	176	176	145	141	151.5	145	154		174
Interorbital breadth	71.5	81.5	58	64	59	77	64	65	72	67	51	57	56	61	63		71
Breadth at postorb. proc.	103	109	81	84	89	109	84	92	97	96	73	80	85	80	87		101
Mastoid breadth	140	143	120	107	123	140	121	133	128	130	108	115	113.5	115	117		135
Palatal breadth at m <sup>1</sup>	42	42	36.5	39	42	46	42	45	43	42	38	38	39	38	40		39.5
Length of upper toothrow	99	104	97	96	97	109	96	97	99	—	91	92.5	94	96	99		98
Length of p <sup>1</sup> -m <sup>2</sup>	55	58	54	52.5	58	54	53.2	54	53.5	56	49	53.5	52	52	51		52.5
“ “ p <sup>1</sup> -m <sup>1</sup>	30	30	29.5	28	30	28.5	28	28	29	31	26	30	29	28.5	28.5		28
“ “ m <sup>1</sup>	17	19	17.5	17	18.5	17	17.3	17.5	17	13	16	17.5	17	17.2	17		16
Breadth of m <sup>1</sup>	13	15	13	13	13.7	14.5	13.5	12	13.5	13	12.5	13.2	14	14	14		13.3
Length of m <sup>2</sup>	26.5	27.5	24	25	28	25	27	27	25.5	27	24	24.5	23.5	24.5	24.1		26.5
Breadth of m <sup>2</sup>	14.5	15	15	14	15	15	15	14	15	15.5	14	15.5	15	14.7	12.2		15
Nasals, gr. length	73	76	69	65.5	63	73	62	68	70	80	57	67	68	75	68		70
Breadth distally	34.5	36	27	31	23	37	23.5	—	29	29	24.3	23	25	25	24		32
“ “ at prem. sut.	21	26	21	26	22	27	22	20.5	24	28	16	21	21	19	20		22

questionably of the same sex, from 22 to 27 mm., or about 20% of the mean. While these variations are evident from the table of measurements, they are far more impressive when the actual teeth are compared, since the shape of the tooth varies as much as the size, especially in the development of the 'heel' portion. This is usually about one-third the length of the tooth, but may be only one-fourth as long. The relation of width to length is also markedly variable.

Three skulls obtained at Rupert House, James Bay, by Mr. Alanson Skinner, in 1908, now in the Department of Anthropology of the American Museum, are of medium size for mature adults, and in general size and in the size and character of the teeth and other parts of the skull are not distinguishable from skulls of corresponding age from the Labrador coast region. They were obtained from the Indians and are without further data.

Variations due to age are an increased widening of the zygomatic arches, and their heavier ossification and squarer posterior angle; the broadening of the rostral and interorbital regions, and the increased mastoid breadth, through the development of the mastoid processes and adjoining parts; and usually the marked building up of the frontal region at and just behind the proximal part of the nasals.

Marked individual variation is shown, as would be expected, in the size and form of the nasals, independently of the general form of the skull. In the table three measurements are given of the nasals — total length, breadth at the front border, and width at the proximal end of the premaxillaries. In most specimens the nasals taper gradually posteriorly from the anterior border and abruptly end in a rounded border; in some instances the posterior border is square, or abruptly truncate or even slightly emarginate on the median line; in rarer instances they terminate in a long V-shaped point.

The material available from other localities, while limited and unsatisfactory, shows that Black Bear skulls from the Mogollon Mountains, Arizona, Fort Klamath, Oregon, Duluth, Minnesota, and from the eastern United States,<sup>1</sup> are in no feature distinctively different from skulls of corresponding age from Labrador. It thus appears that if *U. a. sornborgeri* is to be distinguished as a local race, it must be recognized on the basis of other characters than those afforded by the skull. Such characters are thus far unknown.<sup>2</sup>

<sup>1</sup> Three specimens in the Hays collection, without definite locality, are presumably from the Adirondacks, New York.

<sup>2</sup> Since this article was put in type I have received a letter from Mr. Bangs in which he states that he has reached the same conclusions as those recorded above respecting the invalidity of *Ursus americanus sornborgeri*, and the impossibility of distinguishing the sex of the Labrador bear skulls here under review. He also refers to his 'List of the Mammals of Labrador' in Dr. Grenfell's 'Labrador, the Country and the People' (just published), where (p. 467) he synonymizes *Ursus americanus sornborgeri* with *U. americanus*.

A series of six adult skulls (4 males and 2 females) from the Kenai Peninsula, Alaska, differ slightly from those from Labrador (a series of 24) and elsewhere, in the breadth of the skull being much less in proportion to its length, and hence through the long, narrow form of the skull, in comparison with skulls of *U. americanus* from numerous other localities. This is especially evident in the orbital and rostral portions of the skull, including the palatal breadth. The length of the toothrow is also less and the teeth appreciably smaller. These differences range from 8 to 10 per cent, and are reasonably constant, when the normally wide range of individual variation in cranial characters is considered. In addition to this, the pelage of the Kenai Peninsula Black Bears is intensely black, the blackness usually extending to the base of the pelage, in contrast with the lighter color of the dark phase of the Black Bear from other localities and the proximally more restricted extent of the black in the under fur. From present indications the Kenai Black Bear seems entitled to recognition as a subspecies, and may be called ***Ursus americanus kenaiensis***, with No. 17790, ♂ ad., from Homer, Kenai Peninsula, Alaska, as type.

The following table gives measurements of 6 skulls from the Kenai Peninsula in comparison with 10 from other parts of the United States.



## Article II.—MAMMALS FROM THE ATHABASKA-MACKENZIE REGION OF CANADA.

BY J. A. ALLEN.

During the summer of 1907 Mr. E. Thompson Seton, accompanied by Mr. Edward A. Preble of the Biological Survey as assistant, made an expedition to the Barren Grounds in the vicinity of Aylmer Lake, Mackenzie District, for the purpose of natural history exploration. Their route was by way of the Athabaska River, Slave River, Great Slave Lake, and the chain of lakes northeastward to Aylmer Lake. The birds and mammals obtained on this trip were purchased for this Museum, through the generosity of Mrs. Morris K. Jesup. The birds have already been briefly reported upon by Mr. Seton;<sup>1</sup> for the sake of the localities, and the measurements taken by Mr. Preble from the specimens in the flesh, it seems worth while to record these data for the mammals, which comprise about 270 specimens, and represent 25 species.

The principal points at which collections were made are: Athabaska River, 20 miles below Athabaska Landing, May 18 and 19; Grand Rapids, Athabaska River, May 22-24; Fort McMurray, Athabaska River, May 28, 29; Slave River, June 6-8; Fort Smith, Slave River, on the Athabaska-Mackenzie boundary, June 13-July 2; Great Slave Lake (various points), July 19-27, September 10-27; east shore of Artillery Lake, August 2-5; Aylmer Lake (various points), August 14-29; Artillery Lake (mostly east shore at tree limit), August 31-September 8.

The collection consists mainly of rodents, but lacks representatives of the genera *Phenacomys* and *Synaptomys*; it also contains only a single specimen of *Sorex*, and single specimens each of three species of *Putorius*; also only two specimens of *Lepus*, and one of *Eutamias*. With Mr. Preble's previous long experience in this general region, the scarcity of such forms as these in the collection seems to emphasize the precarious nature of the search for certain mammals that we are apt to associate especially with the region visited. In the case of the Arctic Hare, the visit was made during a year in which its numbers were reduced to a minimum by the great epidemic of 1907.

Among the noteworthy species obtained are a fine old male Musk-ox and a series of specimens of the Barren-ground Caribou.

<sup>1</sup> 'Bird Records from Great Slave Lake Region. A preliminary List of Birds observed by my 1907 Expedition into the Arctic Barren-grounds of Canada.' By Ernest Thompson Seton. Auk, Vol. XXV, Jan. 1908, pp. 68-74.

1. **Rangifer arcticus** (*Richardson*). Seven specimens, skins and skulls, of which four are males and three females; two are fawns about three months old; the others are adults, in the abraded winter coat or in moult. All are from the east shore of Artillery Lake, at tree limit, August 2, except one taken at the outlet of Artillery Lake, August 25. The antlers of the two adult males were not preserved.

The collector's measurements of an adult male and three females are as follows:

Adult male, total length, 1930 mm.; tail vertebræ, 152; hind foot, 520; "weight, after loss of blood and some contents of paunch, 268 $\frac{3}{4}$  lbs."

Adult female, total length, 1590; tail vertebræ, 110; hind foot, 510.

Adult female, total length, 1524; tail vertebræ, 152; hind foot, 483.

Adult female ("just past nursing"), outlet of Aylmer Lake, August 25; total length, 1702; tail vertebræ, 127; hind foot, 508; height, 914.

2. **Ovibos moschatus** (*Zimmermann*). One specimen, a large, very old male, Aylmer Lake, long. 109° 20', August 16.

Measurements: Total length, 96 in. (= 2338 mm.); tail vertebræ, 102 mm.; hind foot, 19 in. (483 mm.); height at shoulders, 59 in. (= 483 mm.

3. **Marmota monax canadensis** (*Erxleben*). One specimen, Fort McMurray, Athabaska River, May 28. Total length, 435; tail vertebræ, 125; hind foot, 75.

4. **Citellus (Colobotis) parryi** (*Richardson*). Twenty-six specimens, skulls without skins, the skins having been lost by the upsetting of a boat: East shore of Artillery Lake (tree limit), August 3 (9); Clinton-Golden Lake, August 12 and 29 (5); Aylmer Lake, August 14, 17 (2); Sandhill Bay, Aylmer Lake, August 20-23 (4); outlet of Aylmer Lake, August 25 (1); near head of Artillery Lake, August 31 (2); east shore (tree limit), Artillery Lake, Sept. 4-6 (3).

Six adult males, from Aylmer and Clinton-Golden Lakes: Total length, 413 (395-430); tail vertebræ, 133 (120-140); hind foot, 63 (60-66). The females are much smaller, the largest female of the series being smaller than the average of the series of males.

5. **Eutamias borealis** (*Allen*). One specimen, male, Fort Smith, June 15. Total length, 210; tail vertebræ, 96; hind foot, 30.

6. **Sciurus hudsonicus** *Erxleben*. Three specimens: Fort McMurray, May 28; Fort Smith, June 17; Fort Reliance, Great Slave Lake, September. Fort McMurray, ♀, total length, 315; tail vertebræ, 130; hind foot, 48. Fort Smith, ♀, 325, 135, 51. Fort Reliance, ♂, 336, 147, 53.

7. **Sciuropterus sabrinus** (*Shaw*). One specimen, Fort Resolution (without skull, date, or measurements).

8. **Peromyscus maniculatus arcticus** (*Mearns*). Sixty-nine specimens,

including young and old in all phases of pelage: Twenty miles south of Athabaska Landing, May 12 (1); Grand Rapids, Athabaska River, May 22-24 (22); Fort McMurray, May 29 (3); Fort Smith, June 13-18, July 1, 2 (31); Oot-sing-grec-ay Island, Great Slave Lake, July 22 (2); Old Fort Reliance, Sept. 15, 16 (3); west end of Ethen Island, Great Slave Lake, Sept. 21, 22 (5); Fort Resolution, Sept. 27 (3).

A series of 22 adult specimens, 11 males and 11 females, all taken on an island at Grand Rapids, Athabaska River, shows a wide range of variation in measurements. The males average slightly the larger, but there is a wide range of individual variation in specimens apparently equally adult, in each series, as follows: 11 males: Total length, 172.5 (162-182); tail vertebræ, 80.8 (73-86); hind foot, 20.5 (20-21). 11 females: Total length, 171 (165-178, with 1 at 193); tail vertebræ, 78.8 (73-82, with 1 at 92); hind foot, 20.1 (19-21).

Another series of 7 adult females from Fort Smith, about 300 miles further north, averages considerably larger, as follows: Total length, 181 (165-196); tail vertebræ, 78 (70-88); hind foot, 20.3 (20-21). They also appear grayer and less fulvous.

These measurements, taken by Mr. Preble, greatly exceed those given for this subspecies by Mr. Osgood in his 'Revision of the genus *Peromyscus*' (N. Am. Fauna, No. 28, 1909, pp. 49 and 260).

9. *Evotomys gapperi athabascæ* Preble. Fourteen specimens: Grand Rapids, Athabaska River, May 23 (2 specimens); Fort Smith, Slave River, June 16, 17 (2); east end of Great Slave Lake, Sept. 10 (4); Fort Reliance, Great Slave Lake, Sept. 15, 16 (3); Ethen Island, Great Slave Lake, Sept. 22 (3).

Measurements of 8 adult females from the lower Athabaska and Slave Rivers: Total length, 130.3 (128-142); tail vertebræ, 33 (28-38); hind foot, 18.3 (18-19).

10. *Evotomys dawsoni* Merriam. Seventeen specimens: North shore of Lake Aylmer, long. 109° 20', August 16-19 (7); Sandhill Mountain, outlet of Lake Aylmer, August 28 (7); Kasba Lake, August 31 (1); Artillery Lake (near head), Sept. 1 (2).

Measurements of 8 adult females from Aylmer Lake are: Total length, 135 (127-146, with one at 155); tail vertebræ, 31.5 (30-33, with one at 37); hind foot, 19 (18-20).

11. *Lemmus trimucronatus* (Richardson). Fourteen specimens, mostly immature: Aylmer Lake, Sept. 7 (1); Sandhill Mountain, at outlet of Lake, August 23-28 (4); north shore, long. 109° 20', August 17-19 (9).

The only fully adult specimen, a male, measured, total length, 158 mm.; tail vertebræ, 24; hind foot, 20.

12. **Dicrostonyx hudsonius alascensis** Stone. Four specimens: Sandhill Mountain, Aylmer Lake, August 26, 27 (2); Artillery Lake, tree limit, east shore, Sept. 4 and 8 (2).

Measurements of three subadult females: Total length, 144, 122, 120; tail vertebræ, 18, 18, 16; hind foot, 18, 18, 17.

13. **Microtus drummondi** (Aud. & Bach.). Thirty-one specimens, mostly immature: Fort Mackay, Athabaska River, May 31 (1); Slave River, 20 miles below Peace River, June 7 (4); Fort Smith, June 14 (1); Sandhill Bay, north shore of Aylmer Lake, August 19–23 (5); Artillery Lake, tree limit, east shore, Sept. 4, 5 (14); Burr Lake, 11 miles east of east end of Great Slave Lake, Sept. 10 (1); Fort Reliance, Sept. 14–16 (4); Fort Resolution, Sept. 27 (1).

The 10 largest adults (mostly females), partly from Slave River and partly from Aylmer Lake, measure: Total length, 160.5 (150–170); tail vertebræ, 46 (41–46, with one each at 49 and 53); hind foot, 19.1 (18–20).

14. **Lepus arcticus canus** Preble. Two specimens, an adult and a young adult female, Aylmer Lake, August 14 and 19 (long. 109° 30'), near Sandhill Bay. They measured, respectively, total length, 625, 570; tail vertebræ, 76, 72; hind foot, 160, 142.

15. **Lynx canadensis** Kerr. Five skins with skulls and 3 additional skulls: Athabaska Landing, Alberta, May 18, 19 (skin and skull and 2 additional skulls); Poplar Point, Athabaska River, June 3 (skin and skull); Fort Smith, June 17, 18 (1 skin and skull and an additional skull); Slave River, 8 miles below Salt River, July 5 (skin and skull); Great Slave Lake, near Fort Reliance, July 27 (skin and skull); Artillery Lake, east shore at tree limit, August 5 (skin and skull). Five of the specimens measured in the flesh as follows:

Adult female, Pelican Portage; total length, 917; tail vertebræ, 133; hind foot, 240.

Adult female, Slave River, 15 miles below Peace River; total length, 934; tail vertebræ, 108; hind foot, 242.

Adult female, Poplar Point, Athabaska River; total length, 890; tail vertebræ, 118; hind foot, 235.

Male, Fort Smith; total length, 950; tail vertebræ, 130; hind foot, 260.

Male, Slave River, 8 miles below Salt River; total length, 915; tail vertebræ, 115; hind foot, 242.

Male, total length, 952; tail vertebræ, 102; hind foot, 234.

16. **Canis occidentalis** Richardson. One skin and skull, Sandhill Bay, Aylmer Lake, August 20, and several additional more or less weathered skulls. The Sandhill Bay specimen measured, total length, 1685 mm. ("5 ft. 6½ in."); tail vertebræ, 470; hind foot, 298.5; height at shoulders, 711 ("28 in.").

17. **Canis latrans** Say. Two weathered skulls, picked up 20 miles below Athabaska Landing, May 18.

18. **Vulpes lagopus innuitus** Merriam. One specimen, Aylmer Lake, long.  $109^{\circ} 20'$ , August 18. Total length, 790; tail vertebræ, 290; hind foot, 138.

19. **Vulpes alascensis abietorum** Merriam. Seven skulls, 20 miles south of Athabaska Landing, Alberta, May 18 (3); mouth of Salt River, Mackenzie, June 18 (1); Fort Reliance, Great Slave Lake, Sept. 15 (2); Fort Smith, Oct. 4 (1).

20. **Lutreola vison energumenos** (Bangs). One specimen (skull only), Nialing River, July 11.

21. **Putorius cicognanii richardsoni** (Bonaparte). One specimen, skull only, Fort McMurray, Athabaska River, May 28.

22. **Putorius arcticus** Merriam. One specimen, Clinton-Golden Lake, south shore, long.  $107^{\circ} 30'$ , August 29. Total length, 365; tail vertebræ, 110; hind foot, 50.

23. **Putorius rixosus** Bangs. One specimen, Old Fort Reliance, Great Slave Lake, Sept. 15. "Taken at corner of house in a mouse trap." Total length, 172; tail vertebræ, 32; hind foot, 21.

24. **Mustela americana actiosa** Osgood. Two skeletons, Fort McMurray, Athabaska River, May 28.

25. **Sorex personatus** I. Geoffroy. One specimen, Fort Smith, June 17.



### Article III.—MAMMALS FROM PALAWAN ISLAND, PHILIPPINE ISLANDS.

BY J. A. ALLEN.

The Museum has recently secured a small collection of mammals from the Philippine Islands, collected by Colonel John R. White, of the Philippine Constabulary. Of the 33 specimens contained in the collection, representing 13 species, 32 were collected at Iwahig, Palawan Island, the other, a specimen of *Muntiacus*, on Balabac Island.

There are several imperfect hunters' skins in the lot, but the greater part are well made skins in good condition. The skulls, however, were left in the skins, and on removal prove to be imperfect, the preparator having removed the posterior portion of the skull.

I am indebted to Mr. Gerrit S. Miller, Jr., Curator of Mammals, U. S. National Museum, for kindly sending me for examination in this connection specimens of *Paradoxurus*, *Arctitis*, and *Mungos* from Borneo and Sumatra, collected by Dr. W. L. Abbott.

1. **Manis** sp. A young adult, skin and skull, of the *Manis javanica* type.

2. **Sus ahencbarbus** *Huet*. Two very young specimens, of different ages, in the striped pelage of the young, are provisionally referred to this species. In one the light stripes are orange rufous, in the other lighter and yellower.

3. **Muntiacus nigricans** (*Thomas*). One specimen, skin and skull, young adult male (last molar just appearing), Balabac Island. As this specimen differs in some details of coloration from the type (also from Balabac), the following detailed description of it is appended.

Front of head fulvous varied with black-tipped hairs, this color extending back to base of ears as two broad superciliary stripes, separated by a band of black beginning on the forehead between the eyes and, broadening and darkening, forming a conspicuous median band of black, merging posteriorly with the general dark color of the dorsal surface; back and sides blackish, the hairs ashy brown (not white as in the type) at extreme base, then bright fulvous tipped with blackish, the fulvous ground color more or less visible at the surface, conspicuously so on the sides; sides of head fulvous, the hairs slightly black-tipped; the naked interramal space bordered narrowly with white, extending forward from the white throat patch, which latter is continued medially backward through the large black shield which covers the foreneck, and with the white bands that border the black area laterally; the throat markings, both white and black, are separated from the white pectoral area by a broad transverse band of fulvous hairs tipped more or less broadly

with black; abdominal region pale fulvous, the hairs, chiefly along the median line, faintly washed with brownish black; lower abdominal and inguinal areas, inside of thighs, and a band on front of hind leg to below tarsal joint pure white; rest of hind limb fulvous, varied proximally with black-tipped hairs; axillary area white, from which a band of white extends downward along inside of forearm; tail dusky with white tip.

Total length (from skin), 540 mm; head and body 475; tail vertebræ, 65; hind foot, 114. The skull is imperfect, lacking the occipital portion, but affords the following measurements: tip of nasals to fronto-parietal suture, 66.5; length of nasals, 27, width in front, 6.3, at base, 11; palatal length, 62; upper premolar-molar series (last molar just breaking through alveolus), 356; greatest zygomatic breadth, 44; least interorbital breadth, 25.

4. **Sciurus steeri** Günther. Two specimens. These agree better with Dr. Günther's second specimen, from Puerto Princesa, Palawan, than with the type, obtained from Balabac. It is perhaps probable that Günther's two specimens represent two separable insular forms. The present specimens differ somewhat from each other in the amount of white and rufous on the ventral surface. In both the white is mainly restricted to the pectoral region; in one it covers about half of the ventral surface, in the other less than one-fourth, while Günther's Palawan example is described as "lower parts pure white, with the exception of the root of the tail; anal region with the borders of the white abdomen brownish red." With this evidence of individual variability it seems undesirable to give a new name to the Palawan form without comparison with additional Balabac examples.

5. **Sciuropterus nigripes** Thomas. Five specimens, 3 adult, 1 young adult, and 1 young still retaining the milk dentition. One only is in normal coloration, like the type (from Puerto Princesa, Palawan); the others are more or less patched with white. Two are entirely white below, and much more than half white above (including the tail), with irregular patches of gray, mostly small. The other two are mostly gray above with small patches of white, and whitish below with small patches of gray.

#### 6. **Mus luteiventris** sp. nov.

Type, No. 29717, Iwahig, Palawan, Philippine Islands; coll. Col. John R. White. Size medium; pelage spiny, strongly so above, weakly so below.

Above dull yellowish rufous, slightly varied with black-tipped bristles; below olive buff, the hairs grayish brown at extreme base; bristles of the dorsal surface silvery white with blackish tips; bristles of the ventral surface wholly yellowish white, and weak, being scarcely appreciable to the touch; ears pale dusky brown; feet very pale creamy white; tail pale brown, unicolor, naked (to the unaided eye but seen under a magnifying glass to be thickly set with short setæ).

Total length (type, from skin), 293 mm.; head and body, 163; tail, 130; hind foot, 28. Skull, too imperfect for full measurements; zygomatic breadth, 14; length of nasals, 12; upper molar series, 5.2.



Three specimens, one adult, the others young adults. The three examples agree perfectly in color, and seem clearly distinguishable from any of the allied forms.

7. ***Felis minuta* Temminck.** Two incomplete hunter's skins and a kitten, apparently only a few days old, are provisionally referred to this species.

8. ***Viverra tungalunga* Gray.** Two adult males.

9. ***Paradoxurus philippinensis* Jourdan.** Three specimens are doubtfully referred to this species. They differ widely in color from each other, but all have three fairly well defined dark dorsal stripes, with the adjoining sides of the back more or less distinctly mottled with dusky spots. One, a young animal still retaining the entire milk dentition, is nearly black on the back, feet and tail, and brownish black on the head; flanks washed with gray due to a subapical whitish band near the tip of the hairs; below lighter, with the tips of the hairs dull silvery.

Of two adult females, one has the head, nape and tail brown with a faint indication of a light band across the front of the head; limbs dark rufous brown; body above pale brown, with three dark central longitudinal stripes and indistinct spots external to the bands, the hairs of the rest of the dorsal area being subterminally broadly ringed with dull silvery white. The other female (unfortunately without the skull) is very much lighter colored, gray being the prevailing tint except on the top of the head, nape, tail, and limbs, mottled with dusky and with three distinct blackish dorsal stripes. An additional imperfect flat skin agrees in coloration with the light colored example last described.

These four specimens, all from the same locality, indicate a wide range of individual variation in coloration.

#### 10. ***Arctitis whitei* sp. nov.**

Type, No. 29740, ♀ ad., Iwahig, Palawan, Philippine Islands; collected by Col. John R. White, for whom the species is named.

Similar in character of pelage and general features of coloration to the other forms of the genus, but notably different in details of tooth structure from the Indian and Sumatra forms, and in the color of the head, which is of the same general color as the rest of the dorsal surface.

General color black washed with fulvous, the basal part of the pelage being deep black, the hairs broadly tipped with fulvous, the fulvous tint forming the surface color on the fore limbs, and the prevailing tint over the greater part of the body. Pelage long and coarse except on the head, where it is short, especially on the nose and facial region, where the prevailing color is dark, the hairs narrowly tipped with whitish. Neck all round and terminal fifth of tail black; outer surface of ears heavily tufted with black, with a narrow white or yellowish white border. Ventral

surface rather thinly haired, the hairs crinkled and more or less wooley, blackish at base broadly tipped with dull fulvous on the chest and inside of fore limbs; the black of the sides encroaches on the thoracic region; abdominal region pale silvery fulvous, continuous over the anal region and along the under side of the tail as a broad mesial band for two thirds the length of the tail. Mystacial bristles very long, reaching to the ears, white or yellowish white. Mammaræ 4, abdominal.

Measurements (type, from skin): Total length, 1310 mm.; head and body, 700; tail vertebræ, 610; hind foot (s. u.), 100, (c. u., 107). The skull lacks the occipital portion, but affords the following measurements: Zygomatic breadth, 75; interorbital breadth, 27.5; postorbital breadth, 32; across postorbital processes, 40; length of nasals, 27.5; breadth of nasals at front border, 14; palatal length, 67.5; palatal breadth (outside to outside of  $m^1$ ), 36.5; length of canine above alveolus, 16. The tooth formula in the type skull is defective,  $m^2$  being absent on both sides, and  $p^1$  on the right side. Another skull, also a female, with dentition complete, gives the following: Interorbital breadth, 28; postorbital breadth, 34.3; across postorbital processes, 41; length of nasals, 27; breadth of nasals at front border, 14; palatal length, 65; palatal breadth (outside to outside of  $m^1$ ), 36; upper toothrow (canine to  $m^2$ ), 40; length of canine above alveolus, 19; breadth of incisors (the series at alveolar border), 15.

Represented by two fully adult females, in excellent condition, except that the skulls both lack the occipital region; also by an adult male skin without skull, and an imperfect flat skin. The male differs from the two females in having the ventral surface much more heavily clothed and of the same coloration as the dorsal surface. The anal area, however, is fulvous and is continued for a short distance on the lower surface of the tail. Otherwise the coloration and character of the pelage is as above described, except that the tail is wholly black for the greater part of its length.

The few specimens of *Arctitis* available for examination in the present connection indicate that the genus consists of a number of easily recognizable forms, and that it is also divisible into two sections of apparently subgeneric value, on the basis of important differences in the structure of the teeth. In a skull from Sumatra (the type locality for the genus)  $p^4$  is triangular with a well developed antero-inner cusp, while  $m^1$  has the inner moiety much narrower than the outer. A skull from India has the same tooth structure, but is very much larger and otherwise different from the Sumatra specimen. In the Palawan specimens these teeth are obtusely oval instead of triangular in outline, and the inner half of the tooth is less reduced and less oblique to the axis of the tooth. There is also a marked difference in the dorsal outline of the skull, which rises rapidly from about the proximal third of the nasals to its highest point behind the orbital region in all skulls seen from Sumatra and India, this striking convexity being, however, much greater in males than in females. In the Palawan skulls (female) the whole top is nearly flat, conspicuously different from skulls of females from India and Sumatra.

The binturong has been previously recorded from Palawan<sup>1</sup> and specimens appear to have been collected there in 1884, by M. Alfred Marche, for the Paris Museum of Natural History.<sup>2</sup>

11. **Mungos palawanus** sp. nov.

Type, No. 29744 (skin only), ♂ ad., Iwahig, Palawan Island, P. I.; coll. Col. John R. White.

Prevailing color above, including tail, yellowish red punctated with black; head much paler and grayer than the body; ventral surface reddish brown, the hairs slightly tipped with yellow; fore limbs dusky; hind limbs like the sides and back. The individual hairs of the dorsal surface are reddish, annulated subapically with black and tipped with yellow, the black annulations more or less visible at the surface.

Length (from skin), head and body, 395 mm.; tail vertebræ, 190; hind foot (s. u.), 50 (c. u., 56). The specimen is without the skull.

The mongoose so long known from the Philippines appears to have always been referred to *Herpestes brachyurus* Gray, the type locality of which is Malacca.<sup>3</sup> A comparison of the present specimen with Gray's description and figure<sup>4</sup> leaves little room for doubt that the Palawan form is a quite different animal from the true *M. brachyurus* of Malacca. It is also so different from the short-tailed mongoose from Sumatra, commonly referred to *M. brachyurus*, as to need no minute comparison with it, the latter being a much larger and a much darker animal.<sup>5</sup>

12. **Aonyx cinerea** (Illiger). Three specimens — a skin with skull and two additional skins.

13. **Tupaia ferruginea palawanensis** Thomas. Three specimens, two adult and a young adult.

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<sup>1</sup> 'Remarks on the Zoo-geographical Relationships of the Island of Palawan and some adjacent Islands.' By A. H. Everett. Proc. Zool. Soc. London, 1889, pp. 220-228, pl. xxiii (map). *Arctitis binturong*, p. 223.

<sup>2</sup> 'Sur la distribution géographique l'*Arctitis binturong* Raffles,' par M. E. Oustalet. Bulletin du Mus. d'Hist. Nat., VII, 1901, pp. 318-320.

<sup>3</sup> *Herpestes brachyurus* Gray, Charlesworth's Mag. Nat. Hist., I, Nov. 1837, p. 578. "Inhabits Indian Islands. British Museum." In 1843 Gray (List of the Specimens of Mammalia in the Collection of the British Museum, 1843, p. 52) gave the species as "The Malacca Ichneumon. *Herpestes brachyurus* Gray, Mag. N. H., I, 578. a and b. Malacca." In the Zoölogy of the Samarang, Vertebrata, 1850, p. 15, he gave "Hab. Malacca, Malayan Peninsula"; here adding also "Borneo." Later Sumatra was included in its range, and in 1889 Everett (P. Z. S., 1889, p. 223) added Palawan. The type locality, however, is obviously Malacca.

<sup>4</sup> Voyage of the Samarang, Vertebrata, pl. iv.

<sup>5</sup> Compared with two specimens from Aru Bay, East Sumatra, kindly loaned to me for examination by Mr. G. S. Miller, Jr., Curator of Mammals, U. S. National Museum.



**Article IV.**—DESCRIPTION OF A SKULL AND SOME VERTEBRÆ OF THE FOSSIL CETACEAN *DIOCHOTICHUS VANBENEDENI* FROM SANTA CRUZ, PATAGONIA.

BY FREDERICK W. TRUE.

PLATES I-V.

The collections of the American Museum of Natural History contain a very fine, nearly perfect skull and a few vertebræ and ribs of a fossil porpoise which the authorities of the Museum kindly placed in my hands for study and description. The specimen is from the marine beds at Pescadores, Santa Cruz Territory, Patagonia, on the Santa Cruz River, about 8 miles above its mouth and was collected in 1899. It bears the catalogue number 9485. I have identified it as *Diochotichus vanbenedeni*.

Before proceeding to the description of this important specimen, it seems to me desirable to give the synonymy of the species, which is as follows:

***Diochotichus vanbenedeni* (Moreno).**

*Notocetus Van Benedeni* MORENO, Rev. Mus. La Plata, Vol. III, 1892, p. 397, pl. ii. (Preoccupied by *Notiocetus* AMEGHINO, 1891.)

*Diochotichus van Benedeni* AMEGHINO, Énum. Synopt. Mamm. Foss. Éocène. Patagonie, Feb. 1894, p. 182.

*Argyrodelphis benedeni* LYDEKKER, Anal. Mus. La Plata, Pal. Argentina, Vol. II (1893), Apr. 1894,<sup>1</sup> Cet. Skulls, p. 12, pl. vi.

Various opinions are held as to whether a generic name differing from an earlier one by one letter only is invalid, but in so difficult a group as the Cetacea, it seems best to consider that such is the case. In this account, *Notocetus* Moreno, 1892, is regarded as preoccupied by *Notiocetus* Ameghino, 1891.

The specimen of *Diochotichus* under consideration consists of (1) a nearly perfect cranium, which, however, lacks the earbones, nasals, palatines and teeth; (2) the mandible, which lacks the condyles and about one-half the symphysis; (3) the atlas and six thoracic vertebræ, all nearly perfect; (4) three ribs, one nearly perfect; and (5) a few miscellaneous fragments. The skull and vertebræ have been partly restored, the anterior end of the symphysis of the mandible, the tips of the processes of the vertebræ, etc., having been added in plaster. The cranium is a little fractured and compressed in the region of the left maxillary notch, so that the breadth across the orbits is less than it was originally. The terminal alveolus is lacking on the right side, and three others in the middle of the series on the same side have been restored. The rami of the mandible are fractured longitudinally and considerably depressed, and 12 pairs of alveoli have been added to the symphysis anteriorly to restore it to its original length.

<sup>1</sup> Fide Trouessart.

The dimensions of the skull, together with those of the type, as given by Moreno, are as follows:

Dimensions of two skulls of *Diocotichus vanbenedeni*.

	No. 9485, Amer. Mus. Nat. Hist. Santa Cruz R., Patagonia.	Type, Bahia Nueva, Patagonia (Moreno).
	mm.	mm.
Total length of skull . . . . .	634	582 <sup>1</sup>
Length of rostrum . . . . .	433	368
Length of braincase . . . . .	118	116
Greatest breadth between parieto-occipital borders . . . . .	142	140
Height of occiput, between upper margin of foramen magnum and occipital crest . . . . .	97	91
Height of foramen magnum . . . . .	40	33
Breadth " " " . . . . .	40	33
Height of occipital condyles . . . . .	46	47
Length of temporal fossa . . . . .	115	102 <sup>2</sup>
Greatest height of temporal fossa . . . . .	74	71 <sup>2</sup>
Least distance between temporal fossæ posteriorly.	128	135 <sup>2</sup>
Breadth between centers of orbits . . . . .	252 <sup>3</sup>	230
Breadth of nasals anteriorly . . . . .	48 <sup>4</sup>	46 <sup>2</sup>
Breadth of rostrum at maxillary notches . . . .	142	114 <sup>2</sup>
Breadth of premaxillæ at same point . . . . .	89	—
Greatest distance between inner edges of premaxillæ in front of nares . . . . .	28	22?
Breadth of rostrum opposite last pair of teeth . .	86	84
Breadth of maxillæ at middle of rostrum . . . .	52	44 <sup>2</sup>
Breadth of premaxillæ at same point . . . . .	30	28 <sup>2</sup>
Greatest thickness of maxillary protuberance . .	28	39
Length of palatine sinus . . . . .	92	95 <sup>2</sup>
Length of superior tooth-row . . . . .	363	315 <sup>2</sup>
Distance between posterior alveolus and maxillary notches. . . . .	59?	60
Length of posterior upper alveolus . . . . .	9	—
Breadth " " " " . . . . .	6.5	—
Length of middle alveolus . . . . .	9.5	7 <sup>2</sup>
Breadth " " " . . . . .	8	5.5 <sup>5</sup>
Length of anterior alveolus . . . . .	11.5	11
Breadth " " " . . . . .	9	6
Length of mandible (actual condition) . . . . .	580	530
" " symphysis (actual condition) . . . . .	282	202
Distance between posterior end of symphysis and posterior border of alveolus of last lower teeth .	80	—
Breadth of mandible at base of symphysis . . . .	56	49

<sup>1</sup> "Without including the part which is lacking."

<sup>2</sup> From the figure.

<sup>3</sup> Twice one half. The actual breadth is a little less, due to compression.

<sup>4</sup> Breadth of cavity in which nasals rested.

<sup>5</sup> Measurements of alveoli from the figure are probably unreliable, as Moreno gives the breadth of a middle tooth as 7 mm.

The agreement of the two specimens in dimensions, as shown by the foregoing measurements, is so close, taken as a whole, that it seems to me to leave no room for doubt that the Santa Cruz skull represents *Diochotichus vanbenedeni*. A few discrepancies, however, which appear to be real ones, deserves mention. The height of the maxillary protuberance in the type-skull, for example, is considerably greater than in the Santa Cruz skull. This difference may be due to age, as in the case of some of the ziphioid whales, to which *Diochotichus* is probably not so distantly related. The distance between the posterior margins of the temporal fossæ, however, is proportionally somewhat greater in the type-skull than in the Santa Cruz specimen, which seems to negative the idea that the former is the older. This is again contradicted by the fact that the nasals appear to be ankylosed to the frontals in the type-skull and some of the teeth remain in the alveoli, while in the Santa Cruz skull both the nasals and the teeth were free, and have been lost.

However these differences may be accounted for, it does not seem to me that they outweigh the close similarity of the two skulls in the form and disposition of the various bones, and in the majority of the dimensions. Some differences which appear to be of importance, but which in my opinion are not really so, will be mentioned in connection with the description of the Santa Cruz skull.

The data regarding the type-skull, which are mentioned in connection with the following description of the Santa Cruz specimen, are taken from Moreno's account and figures.

*Description of the Santa Cruz Skull, No. 9485. Plates I, II, III, Fig. 1, and IV, Fig. 1.*

*Superior aspect.*—Viewed from above, the most noticeable feature of the skull posteriorly is the great extension backward of the margins of the temporal fossæ, the line of which reaches nearly to the middle of the occipital condyles. This overhang is greater than in the type-skull. The occipital crest is arcuate, being convex backward in the median line, and convex forward on each side. Immediately below the crest, the occipital bone is very concave, especially on the sides; but lower down it is convex transversely. The condyles do not project so much as indicated in the figure of the type-skull.

The expanded proximal portion of the maxillæ is nearly horizontal and flat over the greater part of its surface, and quite thin. It is bent upward where it meets the nasals, and the region external to this raised margin is concave, especially on the left side. Over the orbit the maxillary plate is

rather abruptly bent upward, the anterior extremity being the highest. The plate is not greatly thickened in this region, the maxillary protuberance being formed by the frontal rather than by the maxilla. The latter bone does not entirely overlap the orbital plate of the frontal, but leaves the marginal portion of the latter exposed, especially anteriorly, where the uncovered margin of the frontal is 17 mm. broad. This is not shown in Moreno's figures, in which the lines of demarcation between the frontal and maxilla are not indicated.

The maxillary notch is not intact on either side, but appears to have had about the same form as shown in Moreno's figures, the frontal making an angle of about  $45^{\circ}$  with the maxilla. On the right side of the Santa Cruz skull the tip of the frontal is abraded, so that the angle is nearly one of  $90^{\circ}$ .

The portion of the superior surface of the maxillæ immediately in front of the notches is nearly horizontal and rather narrower and thicker and the free margins not so convex as shown in the figures of the type-skull. More anteriorly the superior surface of the maxillæ becomes broader and strongly inclined downward, and at the tip, is nearly vertical. This surface is widest near the middle of the beak and also a little concave.

The premaxillæ, especially on the right side, are thickened at the posterior ends. They do not reach the frontals proximally, being separated by an interval of about 13 mm. They rested against the nasals (lacking in this skull) for about 10 mm. The proximal third of each premaxilla is fusiform in outline, the surface nearly plane and inclined downward and inward. The outer margins of this portion of the premaxillæ are convex and farthest apart opposite the superior nares. The prenasal triangle is depressed and extends about 100 mm. beyond the maxillary notches. In the distal two-thirds the premaxillæ are convex, as in the typical dolphins, such as *Tursiops*, etc. Immediately in front of the triangle, the surface is nearly horizontal, but more anteriorly is inclined at an angle of about  $45^{\circ}$  so as to be nearly in the same plane with the upper surface of the maxillæ. The two premaxillæ are narrowest a little anterior to the middle of the beak, where the breadth between their outer margins is 26 mm.; but more anteriorly they become expanded again, and near the tip their combined breadth is 33 mm. In their anterior expansion, the premaxillæ resemble those of some species of *Squalodon*, such as *S. tiedemani*, *bariensis*, etc. This character is not shown in Moreno's figures of the type of *Diocotichus*.

A large premaxillary foramen is located about 28 mm. in advance of the line of the maxillary notches on the right side of the Santa Cruz skull, and there are two similar foramina on the left side, the more anterior of which is about in line with the foramen of the right side. Deep channels run out of these foramina posteriorly, and extend along the outer border of the



expanded portion of the premaxillæ, at least as far as the line of the middle of the superior nares.

The nasal bones (which are lacking) were about 27 mm. long, and the two together about 41 mm. broad. The posterior end of each rested against a triangular, median projection of the frontal, which separated it from the occipital crest by a distance of about 18 mm. in the median line.

The nasal region is peculiar, and unlike that of any other genus with which I am acquainted, though resembling *Squalodon* in some respects. The posterior upper end of the vomer, instead of being greatly expanded and nearly erect, as in typical delphinoids, consists of a rather thin septum, with a sharp anterior edge, and inclined backward more than 45°. The upper end of the septum is expanded to form a shelf on which the nasal bones rested. Between the nares, the septum, instead of being thin above, is expanded to receive the mesethmoid. The mesethmoid is pushed back to the middle line of the nares, instead of appearing in advance of them, as in most Odontoceti. Behind the nares the narial septum rests on a broad shelf, apparently part of the frontals. The upper surface of this shelf is somewhat grooved, and the grooves lead on each side into a large foramen (about 15 mm. in diameter), which appears to lead directly into the cranial cavity. The foramina of the two sides are not entirely similar, the one on the left side being a little smaller, more irregular, and a little higher up than that on the right side. There is, furthermore, a smaller one external to and somewhat in advance of it. These foramina appear to be for the exit of olfactory nerves, similar ones having been observed by Prof. Abel in *Eurhinodelphis*,<sup>1</sup> though they were much smaller. They also occur in *Squalodon*.

The ossified portion of the mesethmoid which is embraced by the vomer extends anteriorly, as already stated, but very little beyond the nares. In front of it, the median area is occupied by a very wide and deep trough, the sides of which are formed by the vomer and premaxillæ. This trough extends to the end of the beak, but becomes gradually narrower and shallower anteriorly.

The mesial region, just described, differs greatly from the same region in the type-skull, as depicted in Moreno's figures. In the latter, the premaxillæ are represented as meeting in front of the nares and continuing in contact to the end of the beak, so that the vomerine trough is entirely obscured. A careful examination of the figure, however, convinces me that this is probably an error of the lithographer. On each side of the median line, in the region of the prenasal triangle, there is a rather faint line, which probably marks the inner margin of the premaxilla. The area between these

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<sup>1</sup> Mém. Mus. Roy. Hist. nat. Belg., Vol. II, 1902, pl. xvii, fig. 2.

two lines is so shaded that it is perhaps allowable to interpret it as a depression or trough. If, however, the whole mesial area is really in the same plane, it would seem to show that in old individuals the cartilage which occupies the vomerine trough becomes ossified.

*Inferior aspect.*—Viewed from below, the occipital condyles project strongly. The basioccipital has a median ridge, with distinct concavities on each side. The lateral wings of the basisphenoid are of moderate size and thickness, and were not very strongly divergent originally. Their middle portion is occupied by a transverse ridge, convex anteriorly, which meets the median ridge of the basioccipital at the anterior end. The posterior end of the vomer, as preserved, is transverse, and is located 85 mm. anterior to the foramen magnum. Originally, however, it probably extended somewhat farther back. In front of the nares, it extends far downward as a thin ridge ending in a tubercle. The zygomatic processes, though somewhat out of their proper position, were apparently but little divergent. The glenoid fossa is inclined inward and is narrow and very long, its breadth being 36 mm. and its length 84 mm. The postglenoid process is small, short, pointed, and not so strongly recurved as shown in Moreno's figures. The inferior surface of the thick orbital plates of the frontal is not strongly concave distally, but a deep and large concavity occupies the proximal portion. The postorbital process is very large, thick, and prominent.

In front of the nares, on each side of median line, is a large triangular concavity, about 73 mm. long and 35 mm. high at the middle, which might be considered as marking the position of the palatine bones. As there are, however, several parallel furrows in front of it, on the surface of the maxillæ, I am inclined to think that the concavities are really in the vomer, and that the parallel lines represent the palatine suture. If such be the case, the palatine bones are lacking altogether. On the right side, behind and external to the right naris, there is an elongate plate of bone, which probably represents the outer plate of the pterygoid. It articulates posteriorly with an internal process of the zygomatic, as in *Stenodelphis*.

The palate is nearly flat posteriorly, but deeply grooved in the median line in the anterior half. At the distal extremity, however, it is again flat. The vomer is really visible from the nares nearly to the middle of the beak, but this is probably in part due to a slight spreading apart of the maxillæ posteriorly. The visible lozenge-shaped portion, such as is seen in *Eurhinodelphis*, etc., is about 113 mm. long and about 11 mm. broad at the middle. In front of it, the premaxillæ are seen on each side in a deep groove. The latter bones increase very much in breadth anteriorly, and appear to occupy the whole of the terminal portion of the beak for a distance of 41 mm., the two terminal pairs of alveoli, and the greater part of the third pair being in the premaxillæ rather than in the maxillæ.

The superior alveoli on the left side number 21, and a slight depression at the proximal end of the row may represent a twenty-second. On the right side 19 alveoli can be counted, two, or perhaps, three, being lacking at the proximal end of the row. The row is straight except at the proximal end, where it is turned upward. The alveoli are circular in section, but as all of them are inclined forward, the apertures are somewhat elliptical. This forward inclination is greatest at the anterior end of the series. All the upper alveoli are also somewhat inclined outward. The four posterior pairs (on the left side) are a little smaller than those which precede them. The alveoli are irregularly placed, the antero-posterior breadth of the septa varying from 4 mm. to 12 mm.

*Lateral aspect.*—Viewed from the side, the occipital condyles project considerably beyond the line of the exoccipitals. The posterior margins of the temporal fossæ also project very much beyond the surface of the supraoccipital. The margin of the fossa, which is nearly complete on the right side, presents a very peculiar conformation postero-inferiorly. The posterior margin, instead of forming a continuous curve across the suture between the parietal and squamosal, extends vertically downward, and ends abruptly. The portion of the margin which is on the zygomatic process, joins the vertical portion just mentioned about 15 mm. above its free end. The portion of the supraoccipital which extends outward and backward to meet the border of the fossa overhangs the portion of the same bone lower down, being separated by a deep pit opening downward. This unique conformation might very naturally be supposed to have resulted from distortion, but I can conceive of no readjustment of the bones which would make the margin of the temporal fossa continuous. If the zygomatic portion were pushed farther back, the anterior end of the zygomatic process would be too far behind the postorbital process of the frontal. These parts are, indeed, already somewhat too far apart, owing to the fact that the zygomatic process has been pressed upward. From the same cause, the temporal fossa appears smaller than it was originally. (See Moreno's figures.)

The superior border of the temporal fossa, formed by the postero-external plate of the frontal, is nearly straight, but somewhat inclined downward anteriorly. The orbital plate of the frontal, on the other hand, is somewhat inclined upward anteriorly. The angle between them is about the same as shown in Moreno's figures. The postorbital process, as already mentioned, is very long and thick. Its depth is 27 mm. and its breadth antero-posteriorly at the base, 32 mm. The orbit is not strongly arched, and is less than half as long as the temporal fossa.

The zygomatic process is thick, oblong, and obtuse at the extremity. Its outer surface is convex, except proximally, where there is a deep pit.

*Posterior aspect.*—Viewed from behind, the principal features of the skull are the low and broad supraoccipital, bounded above by the very slightly convex occipital crest, the deep pits above the condyles, and the peculiar infolding of the supraoccipital, already described. The foramen magnum is large. The exoccipitals extend outward and backward inferiorly and their surface is convex. Their lower free borders are much below the condyles.

*Mandible.*

As already mentioned, the symphysis is broken off near the middle, and the anterior portion has been restored in plaster. Near its proximal end, the two halves of the upper surface meet along the median line at a slight angle. The two rami meet at an acute angle, which is not noticeably rounded at the apex. There are no distinct traces of grooves on the inferior surface of the symphysis. The condyles are lacking, and the coronoid process is broken. The latter appears to have been long and rather low originally. The orifice of the dental canal is situated at a distance of 164 mm. behind the symphysis.

Ten pairs of alveoli are preserved, of which four pairs are behind the symphysis. They are circular and nearly vertical.

*Tympanic bone.* (Plate III, Figs. 2-4.)

A right tympanic bone accompanies the skull. It is 50 mm. long and appears small in proportion to the size of the skull, although it fits well into the space at the side of the basisphenoid. In form, as well as in size, it so closely resembles the tympanic bone of *Schizodelphis crassangulum* (Case) that had it been found separately, it might have been supposed to belong to that species. The differences are only those of detail, such as less roughness of the surface, etc.

Viewed from below, the bulla is triangular in outline, the posterior border being deeply emarginated, or bilobed, and the anterior abruptly acuminate. The furrow between the outer and inner lips is straight and extends to within 10 mm. of the anterior extremity. The inferior surface of both lips is convex, except for a depression in the inner lip near the anterior end. The middle portion of the inferior surface is rugose.

Viewed from without, the outer lip is oval, being deeper posteriorly than anteriorly, and somewhat projecting. The sigmoid process is thick, crescentic, and but little inclined backward. The surface of the lip is convex and quite smooth.

The inner lip is somewhat more than one-half as deep as the outer. The

anterior half of the upper free border slopes downward rapidly to the acuminate anterior extremity of the bulla. The internal surface is slightly concave near the middle, but convex elsewhere. It is rugose near the lower border. The thickened and convoluted posterior portion of the inner lip occupies rather more than one half its length.

Viewed from behind, the bulla presents two nearly equal, convex lobes, the furrow between them being only a little internal to the middle line. The outer lobe (or lip) extends downward very little beyond the inner lip.

The posterior process of the bulla, which articulates with the periotic, is nearly vertical, but curved inward toward the extremity. It is narrow and convex externally.

The dimensions of the bulla are as follows:

	mm.
Greatest length . . . . .	49
Greatest breadth . . . . .	28
Length of acuminate anterior extremity . . . . .	10
Greatest breadth of outer lip, exclusive of sigmoid process . . . . .	28
The same, including the sigmoid process . . . . .	34
Greatest breadth of inner lip . . . . .	17
Length of the whorl, or convoluted portion from the posterior border . . . . .	28
Length of periotic process . . . . .	21
Breadth of the same . . . . .	8

Vertebræ. (Plate V.)

The skull is accompanied by seven vertebræ; namely, the atlas and six thoracics. The thoracics I consider to be the 1st, 2d, 3d, 5th, 6th and 7th. All the epiphyses are detached from the centra, and only one is preserved. It is very thin.

The atlas, in its general appearance, resembles that of *Inia*, but is far more like that of certain forms from the Maryland Tertiary, which, I believe, represent *Eurhinodelphis*. The vertebra is very long, the neural arch very broad (*i. e.*, antero-posteriorly), and the foramen on either side of it large and completely surrounded by bone. The anterior articular facets are very deep, and are separated below by a wide interval. The postero-inferior median process for the support of the odontoid is short, but very broad.<sup>1</sup> On each side of the body are two superimposed transverse processes, the upper one being much the longer, and directed upward and backward. There is a distinct pit in front of the conjoined roots of the two processes, and a similar one behind them. The posterior articular facets are plane, except at the lower end, where they are narrowed and convex, or rather angular. The body between them in the median line is nearly plane, as is also the

<sup>1</sup> See Moreno's description of the atlas in *Rev. Mus. La Plata*, Vol. III, pp. 399-400, 1892.

upper surface of the process which supports the odontoid. A low, longitudinal ridge occupies the anterior half of the neural arch in the median line and is met by a transverse ridge which extends between the two superior foramina, and rises into a conical projection in the median line. The neural canal is very large, and about as high as broad. It is constricted below the middle on each side, by a projection situated between the anterior and posterior articular facets.

*1st Thoracic vertebra.* The centrum of this vertebra is about one half as long as broad, with the faces somewhat triangular, on account of the flat superior margin. The neural canal and the ends of the centrum have about the same dimensions and form. The neural arch is about as broad antero-posteriorly as the centrum, and much depressed. The spine has been restored, but appears to have been low originally. The anterior and posterior zygapophyses are oval, the former inclined inward and upward, the latter outward and downward. The metapophyses are about as long as the centrum is broad, and are oval and slightly expanded at the extremity. They are on a level with the superior border of the centrum and a little inclined downward and forward.

*2d Thoracic vertebra.* The centrum of this vertebra is triangular, like that of the 1st thoracic, but more depressed, and is more than half as long as broad. The neural arch is broad, the spine longer, inclined forward, and apparently somewhat pointed originally. The metapophyses are shorter and broader than those of the 1st thoracic. They are situated above the level of the upper border of the centrum, and are curved downward at the extremities and slightly expanded. The anterior zygapophyses are well defined, but smaller than the posterior ones, and are placed at an angle with them.

*3d Thoracic vertebra.*—This vertebra resembles the 2d thoracic in most of its characters, but the metapophyses are higher and broader, and are a little inclined upward; the terminal articular facet is elliptical, large, and deeply concave. The neural spine is erect and acuminate. The anterior zygopophyses do not extend forward beyond the line of the anterior border of the metapophyses. They take the form of shallow ill-defined depressions.

*5th Thoracic vertebra.* This vertebra is similar to the 3d thoracic, except that the metapophyses are shorter and less expanded at the end, the neural spine broader, and inclined backward, and the anterior zygapophyses indistinct. The outer sides of the neural arch are concave.

*6th Thoracic vertebra.* This vertebra resembles the preceding, but the metapophyses are still shorter, and are separated from the anterior zygapophyses by an emargination. The latter are again distinct and projecting and are inclined inward. The sides of the neural arch are deeply concave, and there is a low tubercle on the anterior border of the centrum above the

middle. The posterior zygapophyses are small, rather indistinct, high, and close together. The neural spine is very broad.

*7th Thoracic vertebra.* This vertebra is quite unlike the preceding. The anterior zygapophyses are large, close together, deeply concave, and nearly vertical. They are widely separated from the metapophyses, which are lower down than in the preceding vertebra, and are inclined downward. The process on the centrum is restored, but originally was apparently much longer. The two processes, taken together with the side of the neural arch, which is deeply concave, form a nearly complete ring, as in *Mesoplodon* and other genera of ziphioids. The succeeding vertebra probably had a distinct transverse process on a lower level.

In all the characters above enumerated, the vertebræ are thoroughly ziphioid, the genus *Diorchotichus*, if judged by the vertebræ alone, being clearly related to this group of cetaceans.

*Measurements of vertebræ of Diorchotichus vanbenedeni.*

No. 9485, Amer. Mus. Nat. Hist. Pescadores, Santa Cruz, Patagonia.	Atlas	Thoracics					
		1st	2d	3d	5th	6th	7th
Greatest breadth . . . . .	mm. 118	mm. 127 <sup>1</sup>	mm. 117	mm. 113	mm. 94 <sup>1</sup>	mm. 82	mm. 86 <sup>1</sup>
“ height from middle of centrum below . . . . .	87	85 <sup>1</sup>	119? <sup>1</sup>	136	143	144 <sup>1</sup>	—
Length of centrum . . . . .	54	26	33	33	40	44	45
Breadth “ “ (ant.) . . . . .	—	45	48	50	45	46	42
Height “ “ ( “ ) . . . . .	—	39	36	35	35	35	38
Breadth across ant. articular processes	82	78 <sup>3</sup>	77 <sup>3</sup>	60? <sup>3</sup>	—	40?	28
Height of ant. articular processes . . .	47	—	—	—	—	—	—
Breadth of ant. articular processes . . .	31	13 <sup>3</sup>	10 <sup>3</sup>	—	—	—	21 <sup>6</sup>
Height of post. articular processes . . .	39	—	—	—	—	—	—
Breadth of post. articular processes . . .	24	13 <sup>4</sup>	15 <sup>4</sup>	15 <sup>4</sup>	12 <sup>4</sup>	8 <sup>4</sup>	7 <sup>4</sup>
Least breadth of neural arch (antero-posteriorly) external to posterior zygapophysis . . . . .	32	19	14	19	22	29	30
Height of neural spine . . . . .	14 <sup>2</sup>	14 <sup>1</sup>	51? <sup>1</sup>	71	86	92 <sup>1</sup>	—
Breadth of neural spine at base (ant.-post.) . . . . .	—	18	26	34	43	44	40?
Length of superior transverse process . .	28 <sup>1</sup>	38 <sup>5</sup>	38 <sup>5</sup>	50 <sup>5</sup>	41 <sup>5</sup>	35 <sup>5</sup>	31 <sup>5</sup>
“ “ inferior transverse process . . .	5	—	—	—	—	5	22? <sup>1</sup>
“ “ infero-posterior process . . . . .	14	—	—	—	—	—	—
Height of neural canal . . . . .	40	31	35	35	36	31	31
Breadth of neural canal . . . . .	43	43	39	35	33	26	21

<sup>1</sup> Restored.

<sup>2</sup> Transverse ridge.

<sup>3</sup> Anterior zygapophyses.

<sup>4</sup> Posterior zygapophyses.

<sup>5</sup> Metapophysis, from top of centrum.

<sup>6</sup> Nearly vertical; restored.

. *Ribs.* (Plate IV, Figs. 2-4.)

One nearly complete rib, and the upper portion of two others, accompany the vertebrae. They appear to be the 2d, 6th and 7th, or 8th. In the second rib, the neck is long, and the head and tubercle well differentiated, the distance between the centers of the articular facets (as restored) being 51 mm. The greatest breadth of the rib is 24 mm. It is only slightly convex anteriorly, and the angle is rounded.

The sixth rib is more slender and rounded. The tubercle is more prominent, and the neck shorter. Its dimensions are as follows: Distance between centers of articular facets of head and tubercle (as restored) 41 mm.; greatest breadth of rib, 21 mm.

The third fragment, which represents the proximal end of a seventh or eighth rib, is 98 mm. long, and nearly straight. It terminates in a double articular facet, the two parts of which (presumably representing the approximated head and tubercle) are nearly separated by a deep groove. The superior surface of the angle is flattened, with the posterior margin projecting a little. The breadth across the double terminal facet is 32 mm., and the greatest breadth at the angle, 16 mm.

*Relationships of the Species.*

The relationships of *Diachotichus* seem to me to be very clearly indicated by the skull described above. It belongs to the family Squalodontidae, but presents marked differences from *Squalodon* and *Prosqualodon*, as well as striking resemblances. It agrees with *Squalodon* in the general conformation of the frontal plates of the maxillae, which are shorter anteriorly than the thick frontals beneath them. The vomerine trough is very wide and deep. The zygomatic processes of the temporal are thick and oblong in shape. The mesethmoid is large and long. The premaxillae are expanded anteriorly, and twisted at the proximal end. The ethmoid plate is pierced by large olfactory foramina. The symphysis of the mandible is long.

While it corresponds with *Squalodon* in all the foregoing characters, it differs in being much smaller and in having single-rooted teeth, the crowns of which are nearly simple.

The following squalodont and inioid genera have been described from the Patagonian Tertiary:



## SQUALODONTIDÆ.

*Prosqualodon* Lydekk.

1. Type-skull from Port Madryn, Bahia Neuva, Chubut Territory.<sup>1</sup>
2. Mandible, teeth, vertebræ, etc., from San Julian, Santa Cruz Territory. In Princeton University.<sup>2</sup>

*Diochotichus* Amegh.

1. Type-skull and vertebræ from Port Madryn, Bahia Neuva, Chubut Territory.<sup>3</sup>
2. Skull, vertebræ, etc., from Pescadores, mouth of Santa Cruz River, Santa Cruz Territory. In American Museum of Natural History, New York. Described above.

## INIIDÆ.

*Proinia* True.

1. Type-skull from Darwin Station, Santa Cruz Territory. In Princeton University.<sup>4</sup>
2. Cervical vertebra from San Julian, Santa Cruz Territory. In Princeton University.<sup>4</sup>

Dr. A. E. Ortmann has asserted that the Tertiary formations at Port Madryn, San Julian, Darwin Station, and the mouth of the Santa Cruz River belong to one and the same series, the Patagonian beds, and that "the Patagonian beds are Lower Miocene."<sup>5</sup> According to Dr. Ameghino, the genera *Prosqualodon*, *Diochotichus*, *Diaphorocetus* (= *Hypocetus*) and *Scaldicetus*, with others, are found in the formation which he designates as "the Julian, the inferior portion of the Patagonian formation," and regards as Eocene.<sup>6</sup>

Following either of these two authorities, and taking into consideration also the various European species of *Squalodon*, the inference is that in the very early part of the Tertiary, the squalodont type was thoroughly estab-

<sup>1</sup> See Ameghino, Bol. Inst. Geogr. Argent., Vol. XVII, p. 99, 1896.

<sup>2</sup> See True, Smithsonian. Misc. Coll. (Quart. Issue), Vol. LII, pl. iv, p. 447, 1909.

<sup>3</sup> See Ameghino, *loc. cit.*

<sup>4</sup> See True, *loc. cit.*, pp. 441 and 444.

<sup>5</sup> Princeton Patagonian Expedition, Vol. IV, Palæontology, 1, pt. 2, 1901-6, pp. 274, 275, 283, 285, 297, etc.

<sup>6</sup> Anal. Mus. Nac. Buenos Aires, ser. 3, Vol. VIII, pp. 473 and 505, 1906; ser. 3, Vol. I, p. 3, 1902.

lished, and was represented by numerous very distinct forms, comprising at least three genera. Since two of the squalodont genera were living together in the same Patagonian formation with both inioid and physeterine genera, it seems to me hardly probable, as Prof. Abel contends, that the Iniidae were derived from the Middle Miocene squalodont genus *Neosqualodon*, the Physeteridae from the Middle Miocene genus *Squalodon* (type-species, *S. grateloupii*), etc. We must go farther back in time to find the real prototypes of these families. To escape from this conclusion, it would appear to be necessary to assume that the Patagonian beds are of later date than that which has been assigned to them by the paleontologists who have given them the most detailed study. But of this there is, so far as I am aware, no satisfactory evidence at present.<sup>1</sup>

#### EXPLANATION OF PLATES.

##### *Diichotichus vanbenedeni.*

Amer. Mus. No. 9485. Pescadores, Santa Cruz, Patagonia.

##### PLATE I.

Skull, superior aspect. A little less than  $\frac{1}{3}$  nat. size.

##### PLATE II.

The same skull. Inferior aspect. A little less than  $\frac{1}{3}$  nat. size.

##### PLATE III.

Fig. 1. The same skull. Lateral aspect. A little less than  $\frac{1}{3}$  nat. size.

Fig. 2. Right tympanic bulla. Inferior aspect. Nat. size.

Fig. 3. The same bulla. Superior aspect. Nat. size.

Fig. 4. The same bulla. Posterior aspect. Nat. size.

##### PLATE IV.

Fig. 1. Skull. Posterior aspect, showing interrupted posterior border of temporal fossæ. About  $\frac{2}{5}$  nat. size.

Figs. 2-4. Ribs. A little less than  $\frac{2}{3}$  nat. size.

##### PLATE V.

Figs. 1, 2. Atlas. Anterior and posterior aspects.

Figs. 3, 4. First thoracic vertebra. Anterior and posterior aspects.

Figs. 5, 6. Third thoracic vertebra. Anterior and posterior aspects.

Figs. 7, 8. Seventh thoracic vertebra. Anterior and posterior aspects.

All figures about  $\frac{2}{5}$  nat. size.

<sup>1</sup> Notice should, however, be taken of the remark of Dr. E. von Stromer regarding *Prosqualodon*, which is as follows:

"*Prosqualodon* Lydekker, according to its organization and its geological age, should rather be called *Postosqualodon*." (Beitr. Pal. und Geol. Oesterr.-Ung. und Orients, Vol. XXI, p. 172, foot-note, 1908.)

Article V.—ON THE SKULL OF *APTERNODUS* AND THE  
SKELETON OF A NEW ARTIODACTYL.

By W. D. MATTHEW.

PLATE VI.

The specimens here described are from a collection made by Mr. W. H. Reed for the University of Wyoming. I am indebted for the opportunity of describing them to the courtesy of Mr. Reed and the good offices of Prof. S. W. Williston. I take pleasure in expressing my cordial thanks to these gentlemen for the privilege.

The locality is in the neighborhood of Bates's Hole, north of the Laramie Plains. Mr. Reed discovered here a very considerable deposit which he has been successfully prospecting for two or more seasons. The fauna is Lower Oligocene, Titanotherium beds, and includes several skeletons and finely preserved skulls of Titanotheres. Among the smaller mammals submitted to me for identification are, besides the two here described, *Cynodictis paterculus* and *Cylindrodon fontis*, both originally described from the Pipe-stone beds of Montana (Lower Oligocene). It appears therefore that Mr. Reed has discovered a Wyoming locality for the micro-fauna of the Lower Oligocene, similar to those found by Douglass in Montana. The specimens are, so far as I have seen, remarkably well preserved, and a careful study of the whole collection would no doubt yield some interesting results.

Two fossils of special interest are, the complete skull and jaws of an insectivore of the rare and primitive Zalambdodont division of the order, hitherto almost unknown as fossils; and a skeleton of an undescribed genus of Artiodactyla.

SKULL OF *APTERNODUS*.

The insectivore skull and jaws are referable to *Apternodus mediaevus*, described by Matthew in 1903 from several fragments of lower jaws from the Lower Oligocene of Montana. The genus was placed in the Zalambdodont division of the Insectivora.

The skull and jaws discovered by Mr. Reed are of remarkable interest. Fossil insectivora of this group are almost unknown, and the living forms are exceedingly rare. The Centetidæ of Madagascar, *Potamogale* of West Africa, *Solenodon* of the West Indies and the Golden Moles of South Africa are the modern types. *Xenotherium* of the North American Oligocene and

*Necrolestes* of the South American Miocene are the only extinct Zalambdodonts of which the skull is known, and there are six or eight described genera based upon jaws or parts of jaws from the Oligocene and Upper Jurassic of North America. The especial interest of the group is in its extremely primitive skull characters and in the peculiar type of teeth, which according to the Tritubercular theory represent the earliest stage in the development of the mammalian molar.

This specimen is the third and thus far the best preserved Zalambdodont Insectivore from the North American Tertiary.

The generic characters are as follows:

Dentition  $I_2^2 C_1^1 P_3^3 M_3^3$ . Median incisors somewhat enlarged, with oval roots (crowns not preserved); lateral incisors round-cusped with minute heel. Canines two-rooted, crown a stout, recurved cusp with no heel.  $P_2^2$  small, one-rooted.  $P_3^3$  three-rooted, triangular, with large high central cusp, and basal cingulum rising into sharp basal cusps at the angles. Upper molars of essentially similar constitution but more extended transversely. The outer marginal cusps are higher than the inner one, and form with the central cusp a trigon which wears against the trigonids of the lower teeth.  $P_3$  is two-rooted, with basal cingulum surrounding a high sharp-conical cusp. In  $P_4$  a high trigonid is formed by the addition of anterior and posterior cusps to the inner side of the high angular principal cusp, and there is a minute heel at its posterior base.  $M_{1-3}$  are similarly constructed, the heel becoming successively larger, but even in  $m_3$  it is very small relatively to the trigonid and far below its level.

*Skull.* The skull has about the size and proportions of *Ericulus*. The basicranial and basifacial axes are parallel. The face is rather short, the postorbital region long and cylindrical, the occipital region broad and short. Orbits imperfectly defined, lachrymal foramen large, marginal, postorbital process of frontal rudimentary, zygomatic arches absent. Sagittal crest prominent, occiput broad and low with moderately strong crest above. The most remarkable feature of the skull is the extraordinary development of the lateral exposure of the mastoid, which with the adjoining parts of the exoccipital and squamosal bones forms a large lateral plane surface of rectangular form continuous with the outer end of the post-glenoid process, and bounded by four prominent heavy crests which project in a vertical plane. The upper crest projects nearly as high as the base of the sagittal crest, the lower crest is considerably below the level of the condyle, the posterior crest projects a little farther back than the occipital condyle, the anterior crest continues upward from the glenoid. The occipital crests end at the posterior upper corner of this plate. The superior and posterior margins of the plate are evidently a development of the lambdoidal crests, and the anterior border is

the remains of the zygomatic process of the squamosal. The inferior crest is evidently composed of the united paroccipital, mastoid and posttympanic processes. I can find no analogue for this extraordinary development.

The occiput is broad, low, concave, bounded by the occipital and posterior lambdoidal crests, consequently composed of the occipital bones only. The foramen magnum is wide but not high, the condyles narrow and wide apart. The basioccipital region is broad and rather short, the petrosal prominences project a little beyond the level of the basioccipital, and between them and the postglenoid process lies a large deep pit, while externally and posteriorly they lie against the base of the mastoid-paroccipital crest. The condylar and jugular foramina are distinct and well separated. The postglenoid process is very broad and heavy, without postglenoid foramen. The glenoid articulation is wide and deep. The pterygoid plates are not very prominent. The palate is of the usual Insectivore type; it is not extended behind the molars and is bounded posteriorly by a rather strong ridge.

The lower jaw has already been described by Matthew (1903). It is short and deep with wide heavy condyle, coronoid process of moderate height, angle prominent and considerably incurved, masseteric fossa deep. The posterior mental foramen lies beneath the anterior part of  $p_3$ .

The resemblance to *Ericulus* in the dentition is sufficiently marked — but in none of the Centetidæ do I find any near approximation to the extraordinary characters of the mastoid region of the skull. Setting aside this single specialization the genus may be satisfactorily associated with the Centetidæ, and until additional distinctions in skeleton structure are known, it seems best to regard this specialization as of not more than subfamily value. I place *Apternodus* therefore in a subfamily *APTERNODONTINÆ* of Centetidæ, distinguished from *Ericulinæ* by the peculiar development of the mastoid region.

The close resemblance in the construction of the molar-premolar series makes it very probable, that their structural evolution has been uniform. If this be true the following will result as to the molars in *Zalambdodonta*.

1. The high median cusp is the original cusp, corresponding to the protocone of the premolars.

2. The development of the two outer cusps of the upper, and of the two inner cusps of the lower trigon, proceeds pari-passu.

3. The development of the inner heel of the upper, and the posterior heel of the lower molars is correlated.

4. The method of complication of the premolars is not analogous to that of the ordinary trituberculata. If the premolar analogy argument has any force the same is true of the molars.

5. The order of cusp development indicated is substantially that advocated by Cope and Osborn in their tritubercular theory.

6. Fairly typical Zalambdodont teeth occur in the Jurassic, along with teeth of the normal tritubercular pattern, and at least one other distinct type. There is no reason to believe that these different types are stages in the development of the normal mammalian molar, nor that one is derivable from the other. On the contrary they appear to be independently evolved from the primary reptilian cone, and it is probable that a great number of parallel evolutions took place, some of which have survived, while others have not.

If these conclusions be correct, neither Osborn's derivation of the tritubercular molar from the zalambdodont, nor Gidley's derivation of the zalambdodont from the tritubercular are warranted; the identifications of cusps by Osborn in the tritubercular, and by Gidley in the zalambdodont molar are not warranted, and if the premolar-analogy argument be admitted, are incorrect. Osborn's view is correct for the zalambdodont molar, while for the normal tritubercular type the evidence adduced by Scott, Woodward, Wortman, and Gidley points to another method of complication.

According to Leche's view, the molars of the Talpidæ and Soricidæ are derivable from the zalambdodont type, while those of Erinaceidæ and other Dilambdodont families are derived from the normal tritubercular type exemplified in the Leptictidæ. This view is not supported by what is known of primitive Talpidæ and Soricidæ, as these show a molar construction much more like that of Leptictidæ and with little if any approach to the zalambdodont molar. Their premolars also show the normal method of complication.

#### *Eotylopus reedi* gen. et sp. nov.

Type, a skull, jaws and skeleton from the Lower Oligocene of Wyoming in the Museum of Wyoming University. The specific name is in honor of the discoverer, W. H. Reed, curator of the University museum. Mr. Reed's contributions to science as discoverer of the great fossil fields of the Laramie Plains with their wonderful dinosaur fauna described by the late Professor Marsh, are well known to palæontologists.

*Generic characters:* Dentition unreduced, teeth continuous without diastemata. Canines slightly larger than adjoining teeth. Anterior premolars simple, compressed,  $p^3$  with inner cusp,  $p^4$  with inner crescent, moderately wide transversely. Molars brachydont, rather wide transversely, the outer crescents with prominent external ribs and mesostyle, weak para- and metastyles, the anterior inner crescent bifid posteriorly, one crest extending posteriorly, the other externally from the top of the crescent.

Skull of moderate length, no lachrymal vacuity nor fossa, orbits nearly closed behind, bulla of camelid type, folded upon itself and filled with cancellous tissue as in *Poebrotherium*.

Ulna and radius coössified and distinctly of camelid type, with no channel between the two shafts. Fibula reduced to a distal nodule and presumably a proximal vestigial splint.

Podial bones separate. Toes 4-2, median pair of metacarpals and metatarsals separate, moderately long, not appressed, lateral metacarpals slender, complete, lateral metatarsals reduced to nodules.

*Specific characters.* In the absence of more than one species the specific characters are included in the general description that follows.

The generic characters as cited place *Eotylopus* in my opinion as a very primitive and somewhat aberrant ancestral type of the Camelidæ. The molars and premolars are much more like certain *Hypertragulidæ*, especially *Heteromeryx*, and the peculiar bifid protoselene is paralleled in certain of the Giraffi-

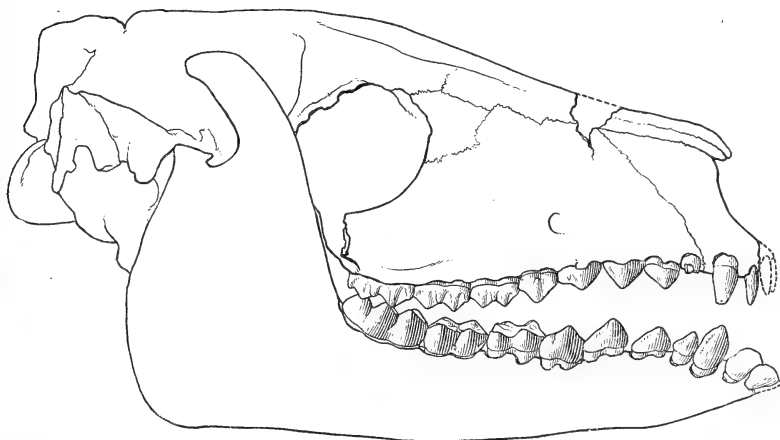


Fig. 1. *Eotylopus reedi*, skull and jaws. Type specimen, two-thirds natural size. Lower Oligocene, Wyoming.

dæ and Bovidæ. The anterior teeth are of rather indifferent type, but the nearest likeness is to *Poebrotherium eximium*. The peculiar type of bulla is however very strong evidence of camelid relationship, and compares closely with that of *Poebrotherium*. The absence of lachrymal vacuity and the general form and proportions of the skull support the relationship to *Poebrotherium*. The consolidation of ulna and radius is likewise of the peculiar camelid pattern, quite different from the consolidation in *Heteromeryx*, *Hypertragulus* or any of the Pecora.

*Dentition:* The upper incisors are three in number, pointed sub-spatulate, increasing in size from first to third. The upper canine is not complete, but was larger than  $i^3$  and, like it, had a pointed crown. The upper premolars are all two-rooted, the first larger than the second, both with compressed elongate crown and no cingulum, while the third has a strong inner basal

cingulum rising to an irregular double cusp or series of cusps a little behind the middle of the tooth.

The fourth premolar has the inner crescent complete. It is considerably wider transversely than long anteroposteriorly, and within the posterior wing of the inner crescent lies an accessory cuspule of irregular form.

The molars are quadrate, somewhat broader than long, and very low-

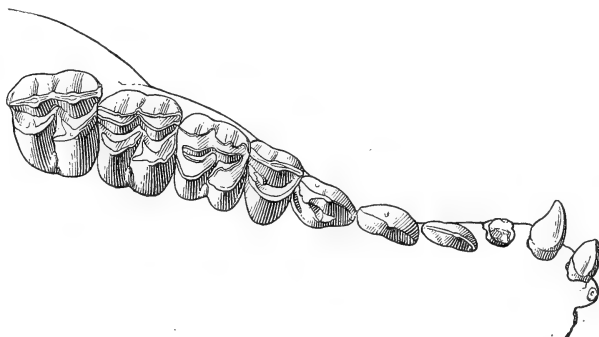


Fig. 2. *Ectylopus reedi*, upper teeth. Natural size, type specimen.

crowned. Their most marked peculiarity is the double posterior wing of the anterior inner crescent; the crest which appears to continue the crescent having the position of the corresponding part in an *Anoplotherium* molar, while a somewhat less prominent crest has the position of the normal ruminant molar. It is very suggestive of a transition from one type to the other, but there is little evidence for this view in other directions. In the Giraffe

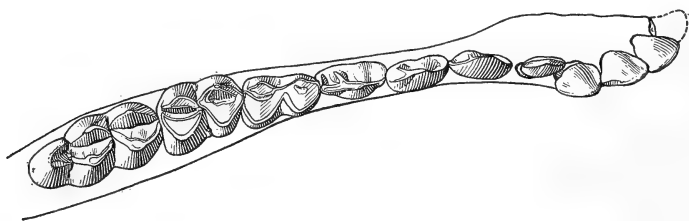


Fig. 3. *Ectylopus reedi*, lower teeth. Natural size, type specimen.

the abnormal wing appears as a weak crest, the normal wing being the principal crest; *Ectylopus* reverses this condition. The size of the molars increases slightly from first to third.

The lower incisors have flattened spatulate crowns, somewhat larger than the corresponding upper teeth. The lower canine is somewhat larger than  $i_3$ , with pointed spatulate crown, the first premolar is one-rooted and



relatively small, the others are two-rooted and all have compressed low pointed crowns with posterior internal crests on  $p_3$  and  $p_4$ .

*Feet:* The camelid affinities already observed are strengthened by the characters of the fore and hind feet. These are intermediate between *Protylopus* and *Poebrotherium*. They have the proportions of the former genus, entirely lacking the long, slender, appressed metapodials of the latter. But they show certain distinctively tylopod features in comparison with corresponding parts of the propecoran and protraguline members of the Hypertragulidæ. In the fore-foot, the lateral digits are complete although slender, the median pair are but slightly appressed. The magnum and trapezoid are separate, the trapezium is not preserved but its presence is indicated by a facet on the trapezoid. The distal keels of the metapodials are confined to the palmar surface; the dorsal surface of the distal facet is slightly convex laterally, less so than in *Protylopus*, more than in *Poebrotherium*.

In the hind foot the lateral digits are reduced to nodular rudiments as in *Poebrotherium* but larger; the median pair are much shorter and less appressed than in *Poebrotherium*, more as in *Protylopus*. The median channel characteristic of the Pecora is not indicated here; on the other hand the heads of the metatarsals show the strong plantar processes characteristic of *Poebrotherium*. The navicular and cuboid are separate, the astragalus is more oblique than in any later Camelidæ, but less so than in Oreodonts. The calcaneal fibular facet has the characteristic camelid form, differing from that of Oreodonts in its greater convexity from front to back, from Pecora in its less convexity from side to side. The phalanges are short, intermediate in type between those of *Protylopus* and *Poebrotherium*, narrower than those of Oreodonts, broader than those of *Leptomeryx*, *Protoceras* and the Pecora.

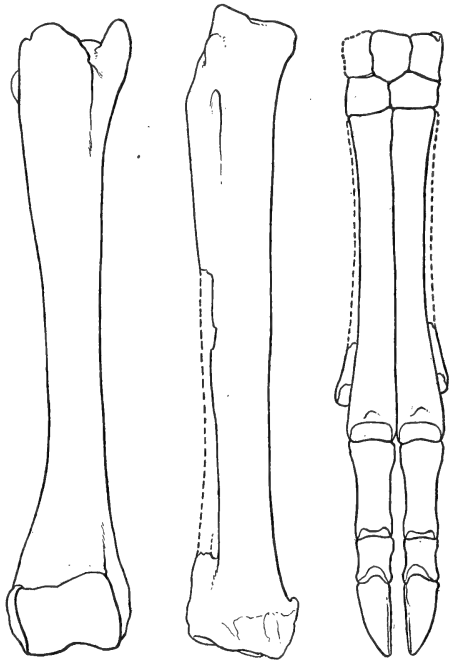


Fig. 4 *Eotilyopus reedi*, fore limb. Type, two-thirds natural size.

*Eotylopus* is evidently a very primitive ancestor of the Camelidæ, aberrant in certain features of the dentition, in other respects intermediate between *Protylopus* and *Poebrotherium*, but much nearer the former. It is probable that the jaw fragments and teeth which I referred in 1903 to *Leptotragulus* (*L. profectus* Matthew) from the Lower Oligocene of Montana, belong to this genus, although they do not agree well enough for specific identity.

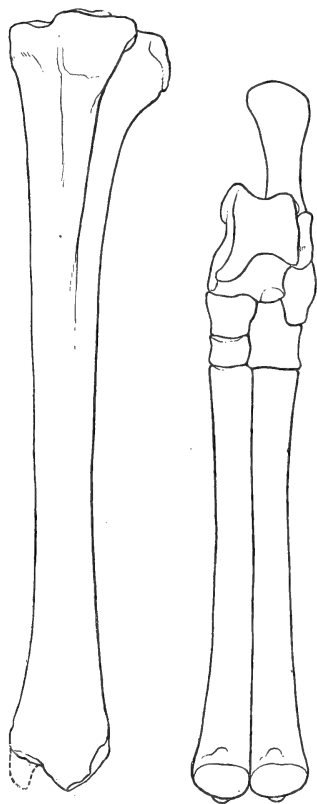


Fig. 5. *Eotylopus reedi*, hind limb. Type, two-thirds natural size.

The neck, judging from Mr. Reed's photograph of the skeleton as mounted in the Wyoming University Museum, was quite short, and this might also be inferred from the shortness of the limbs and feet, and of the head. The proportions of the known parts of the skeleton in *Protylopus* clearly indicate that this genus also had a short neck.

It differs from *Leptotragulus* in the lack of diastema in the lower jaw, from *Protylopus* and others of the better known Uinta genera in the peculiar construction of the upper molars and various other features; but its nearest relationship in skeleton structure is undoubtedly with *Protylopus*. It certainly cannot be regarded as an intermediate stage in the evolution of *Protylopus* into *Poebrotherium*; on the contrary it throws a great deal of doubt on this alleged direct line of descent, for the following reasons:

1. *Eotylopus* is very much closer to *Protylopus* than to *Poebrotherium* and might much more readily be derived from it. This is apparent in its brachyodont teeth, construction of molars and of premolars, proportions of skull, length of limbs, length and character of metapodials, etc.

2. *Poebrotherium* cannot be derived from *Eotylopus* but occurs with it in the Lower Oligocene although much more abundant in the Middle Oligocene. It appears much more probable therefore that *Protylopus* led up into *Eotylopus* than into *Poebrotherium*.

3. Analysis of the Lower Oligocene fauna shows it to be composed of a few types closely allied to Eocene genera, associated with a much larger

number of more advanced types closely allied to the Middle Oligocene fauna, usually congeneric. *Poebrotherium* belongs to the latter group.

This is true of most of the phyla which have been supposed to run through from the Eocene into the Oligocene. We may perhaps regard the more primitive types as autochthonic; the others are more probably immigrants from the north and in the Oreodon fauna they had almost wholly displaced the older forms. *Poebrotherium* is probably derived, not from *Protylopus* of the Uinta, but from some more advanced contemporary genus of more northern habitat.

If, however, we confine ourselves to the broader relations of *Eotylopus*, without making any unprovable assertions as to its direct genetic relations to other known genera and species, but regarding it as one of the successively closer approximations towards the modern Camelidæ which characterize the successive faunal zones of the Tertiary, we find in it a new and interesting stage in the Camelid phylum. While it makes any direct descent of *Poebrotherium* from *Protylopus* less probable, yet it serves to confirm the position of the latter as an ancestral Camelid. Its close relations to the Eocene genus are obvious, and its position in the Camelid phylum appears to be beyond question. Its family position will depend upon the criteria of classification that we adopt. If we adopt the "linear" system and ignore the more important and obvious structural differences between animals, on the plea that they are merely stages in specialization, if we scatter apart a closely related group of ancestral forms among the widely divergent types to which they have given rise, we involve ourselves in a very doubtful and changeable arrangement, dependent upon hypotheses of relationship instead of facts of structural affinity. The groups will be definable only by certain minor features of structure which have escaped alteration and we wholly lose sight of the near relationship of the ancestral stages of various divergent groups. It is to my mind neither necessary nor wise to attempt this method of classification, and its failure is very well shown in the shifting and uncertain position of so large a part of our early Tertiary faunæ. It is not that opinions have really changed very much, but that a vicious method of classification has made a slight change in relationship responsible for a very wide change in classification.

The genus is by definition a member of the Hypertragulidæ, having four digits with separate metapodials in the fore foot, and but two functional digits in the hind foot, the metapodial keels confined to the palmar surfaces, the dentition primitive, brachyodont and unreduced. The family as thus defined is ancestral to the higher ruminants, and if subdivided into three groups ancestral respectively to the Pecora, Tragulina and Tylopoda we would have the following arrangement:

## Leptomerycinae.

*Leptomeryx* with affinities to Cervidæ.

*Heteromeryx*

*Protoceras*

? *Syndyoceras*

} ? giraffine and ?? bovine affinities.

## Hypertragulinae.

*Hypertragulus* affinities to Tragulidæ.

## Leptotragulinae.

*Leptotragulus*

*Eotylopus*

*Protylopus*

} affinities to Camelidæ.

? *Hypisodus* — affinities to Stenomylinæ.

**Article VI.**—ON THE OSTEOLOGY AND RELATIONSHIPS OF  
*PARAMYS*, AND THE AFFINITIES OF THE  
 ISCHYROMYIDÆ.

BY W. D. MATTHEW.

The Ischyromyidæ are a family of primitive Rodents characteristic of the American Eocene, with a few survivors in the Lower and Middle Oligocene of this country. They are the oldest known fossil rodents, appearing first in the Lower Eocene (Wasatch) and are practically the only known group until the end of the Eocene. They are thus of especial interest in tracing the history and evolution of the Rodentia and the relationship of the various modern families.

The best known genera are *Ischyromys* Leidy, of the Lower and Middle Oligocene (White River group), and *Paramys* Leidy, of the Lower, Middle, and Upper Eocene (Wasatch, Wind River, Bridger, Washakie and Uinta formations). Imperfect skulls and some parts of the skeleton of these two genera have been described and figured by Cope (1885) and their relationships considered by subsequent students of the Rodentia. The remaining genera have been known only from jaws, and mostly from very incomplete descriptions, so that almost nothing is known of their affinities.

The present contribution is based chiefly upon a series of fine skeletons and skulls of Rodentia from the Bridger formation (Middle Eocene) obtained by the American Museum Expeditions of 1903-6. This material gives us for the first time a fairly complete knowledge of the osteology of the oldest known fossil rodents. It furnishes very important evidence in regard to the evolution of the Simplicidentate Rodents, and the relationships of the several modern groups.

The modern rodents have been thoroughly studied and extensively monographed by various writers, but comparatively little attention has been paid by these writers to their geological history. This is not surprising in view of our very imperfect knowledge of the extinct forms. Fossil rodents are very numerous and varied, but not in proportion to their modern abundance, and on account of their small size the great majority are very imperfectly known, principally from jaws or teeth. They first appear in North America in the Lower Eocene (Wasatch), in Europe in the Middle or Upper Eocene (Egerkingen), in South America in the Pyrotherium beds (Upper Eocene or Oligocene), in Africa in the Fayûm deposits (Upper Eocene or Oligocene). In other parts of the world nothing is known of their first

appearance, as early Tertiary deposits are unknown, or fossil mammals have not been found in them.

The ordinal characters of the Rodentia are well marked at their first appearance, and they do not appear to be directly derivable from any known Basal Eocene or Cretaceous mammals. The later Tertiary rodents are for the most part nearly related to living genera, and are referred to modern families. The North American Eocene rodents and a part of the Oligocene genera are referred to the extinct family Ischyromyidae. The genera of the European Eocene and Oligocene have been in part referred to the extinct families Theridomyidae and Pseudosciuridae. There are also several aberrant specialized groups of later Tertiary rodents which are placed in extinct families.

#### Family ISCHYROMYIDÆ Alston, 1876.

Alston included in this family *Ischyromys* Leidy, 1856, and perhaps *Pseudotomus* Cope, 1872, with the following definition: "Dentition as in Sciuridae. Skull resembling Castoridae, but with the infra-orbital opening large, a sagittal crest, no postorbital processes, palate broad, basioccipital keeled." *Plesiarctomys*, *Paramys* and *Sciuravus* he referred to the Sciuridae. Cope in 1884 defined the family as follows:

"Dentition as in Sciuridae; infraorbital foramen large, superior; pterygoid fossa large, with well developed exterior as well as interior walls; a sagittal crest." The description of the infraorbital foramen as "large" is somewhat misleading; it is not larger than in *Aplodontia*, and is not large as in Hystricomorphs, nor superior in position as in the Myomorphs. The sagittal crest is not present on *Sciuravus*. The keeled basioccipital is present only in *Ischyromys*.

On our present knowledge the family may be defined as follows:

Infraorbital foramen small or of moderate size, round, postero-inferior in position, situate close to the antero-inferior margin of the orbit, and facing forward and downward, so that it was probably not traversed by any portion of the masseter. Origin of masseter wholly limited to the zygomatic arch, not extended forward on the side of the muzzle in advance of the orbits.

Dentition  $\frac{1.0.2.3}{1.0.1.3}$ ; teeth brachyodont, sciurid in pattern or with imperfect transverse crests. Palate broad and grinding surfaces approximately horizontal.

Tympanic bulla incompletely ossified and loosely attached in earlier genera (complete in *Ischyromys*).

Zygomatic arch moderately deep, jugal extending upward in front of orbit to meet the lachrymal. Premaxillae broad posteriorly, almost exclud-

ing frontals from contact with maxillæ. Nasals long, and broad posteriorly; facial extension of lachrymals not large. No postorbital processes on frontals; post-tympanic plate of squamosal broad; mastoid exposure small.

Neck moderately long, tail very long and strong; limbs and feet of moderate length, arboreal to terrestrial in adaptation; manus tetradactyl with vestigial pollex; pes pentadactyl, lateral digits well developed; scaphoid, lunar and centrale separate.

### **Paramys** *Leidy*, 1871.

*Paramys* LEIDY, 1871, Proc. Acad. Sci. Phila., Vol. XXII, p. 231 (published Nov. 28, 1871); Ext. Vert. West. Terrs., p. 109, pl. vi.

*Pseudotomus* COPE, 1872, Pal. Bull. No. 2, issued Aug. 3, 1872; Proc. Am. Phil. Soc., Vol. XII, p. 467.

*Plesiarctomys* COPE, 1877, Ext. Vert. New Mex., p. 170; 1885, Tert. Vert., p. 175.

?*Plesiarctomys* BRAVARD, 1848-52, in Gervais, Zool. et Pal. Franc., pt. ii, expl. pl. xlvii.

*Nomenclature.* This genus was founded upon three species from the Bridger formation, *P. delicatus*, *delicior* and *delicatissimus* Leidy, known

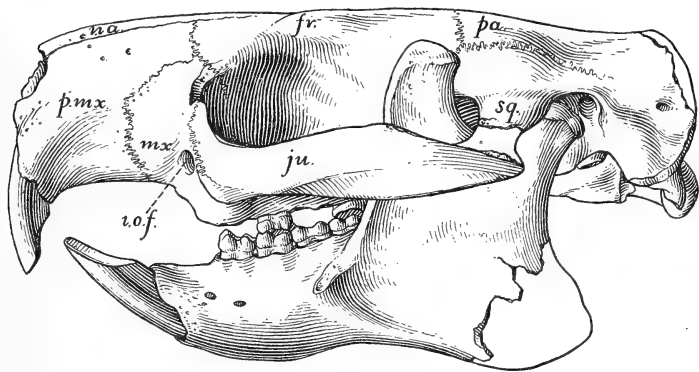


Fig. 1. *Paramys delicatus*, skull and lower jaw, natural size, No. 12506. Lower Bridger, Wyoming.

only from parts of lower jaws. *Pseudotomus*, type *P. hians* Cope, was based upon a skull from the same formation, lacking the cheek teeth and otherwise defective, but with complete incisors. Both genera were subsequently synonymized by Cope with *Plesiarctomys* Bravard, type *P. gervaisi* Brav., based upon an incomplete lower jaw from the Upper Eocene of France. This identification has been generally accepted, but in recent years several

authors<sup>1</sup> have revived Leidy's genus, although without giving any reasons for separating it from *Plesiarctomys*.<sup>2</sup>

It is entirely probable, in my opinion, that *Plesiarctomys* and *Paramys* are identical or closely allied genera, although there are some marked differences between the teeth of the typical species. In *Plesiarctomys gervaisi*, according to Gervais's figure,  $p_4$  is short and small, more reduced than in *Arctomys*, and the molars increase regularly in width and length from  $p_4$  to  $m_3$ . In *Paramys delicatus*,  $p_4$  is a much larger tooth, longer than  $m_{1-2}$ , and as wide as  $m_1$ ; its two anterior cusps are more separated and of larger size. Other species of *Paramys*, however, especially *P. robustus* and *P. (Ischyrotomus) petersoni*, approach very closely to the type of *Plesiarctomys* in dentition. Unfortunately Gervais does not figure the outside of the jaw, so that

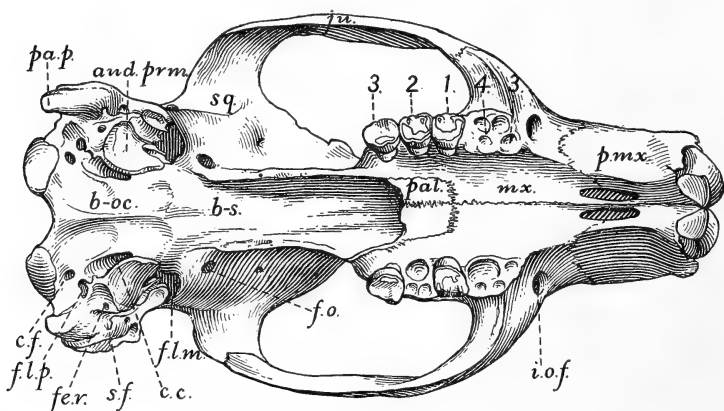


Fig. 2. *Paramys delicatus*, under view of skull, natural size, No. 12506. Aud. prm., auditory prominence of petrosal; b.-oc., basioccipital; b.-s., basisphenoid; c.c., carotid canal; c.f., condylar foramen; f.e.r., fenestra rotunda; f.l.m., foramen lacerum medium; f.l.p., foramen lacerum posterius; f.o., foramen ovale; i.o.f., infraorbital foramen; ju., jugal; mx., maxilla, pal., palatine; p.mx., premaxillary; pa.p., paroccipital process; s.f., stylomastoid foramen; sq., squamosal.

we do not know whether the French genus resembled *Paramys* or *Sciurus* in the more important diagnostic characters which would determine its family relations. I have failed to find any figures or descriptions of European specimens which would throw any additional light on this point; pending a reëxamination of the type in the British Museum, I regard the identity of the two genera as *sub judice*, and retain Leidy's name provisionally for the American forms.

<sup>1</sup> Zittel, 1893; Osborn, 1895; Matthew, 1899; Hay, 1902; Loomis, 1907.

<sup>2</sup> Except Osborn, 1895, the single hint of distinction there given being inapplicable to the type species of the two genera.



*Generic Characters.* Dentition  $\frac{1.0.2.3}{1.0.1.3}$ . Teeth sciurid in pattern but anterior ledge of upper molars rudimentary, entoconid a distinct cusp instead of a marginal ledge, paraconid and metaconid less widely separated than in modern *Sciuridae*. Cusps low, more or less marginal, little or not at all crested; upper molars tritubercular, hypocone absent or small; lower molars with broad shallow basin heels. Incisors broad or of moderate width, with convex anterior face (except subgen. *Ischyrotomus*, infra).

Skull proportioned as in *Arctomys*, but with shorter muzzle and longer basicranial region. Preorbital region as in *Aplodontia*, the infraorbital foramen of moderate size, facing partly downward, situate just in advance of  $p_3$  and mainly below the level of the orbit. Origin of masseter wholly behind infraorbital foramen, as in *Aplodontia*, not extended forward above

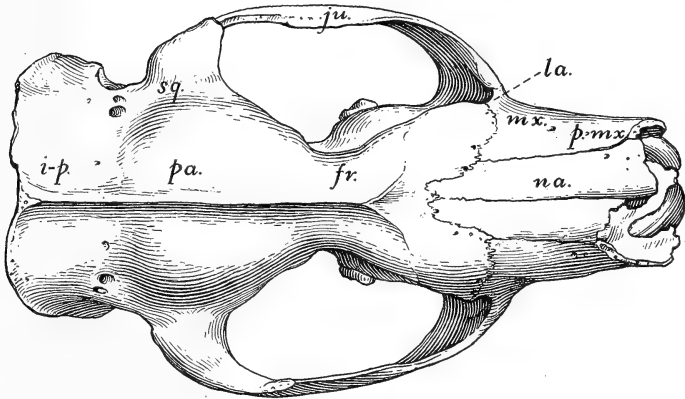


Fig. 3. *Paramys delicatus*, top view of skull No. 12506.

it as in *Sciuromorpha* generally, nor beneath the major portion of it, as in *Myomorpha*, nor through it as in *Hystriomorpha* (and to a varying extent in *Myomorpha*), but wholly confined to the zygomatic arch, and not reaching the skull in front of the arch. Postorbital constriction narrow, no post-orbital processes. Premaxillæ very wide posteriorly (*cf. Aplodontia*) almost excluding contact between maxillæ and frontals. Facial expansion of lachrymal limited, as in *Arctomys*. Sagittal crest low, but extending forward in advance of postorbital constriction. Parietals long, reaching forward nearly to postorbital constriction. Post-tympanic process of squamosal broad, completely overlapping mastoid region, save for a small lateral exposure between paroccipital and post-tympanic processes. Paroccipital process short, projecting backward rather than downward. Bulla absent in all our specimens, probably incomplete and loosely attached (as in *Sciuravus*).

The alisphenoid canal and the larger tunnel internal to it are much as in *Arctomys*, and the transverse canal perforating the basisphenoid is apparently present but not large. There is a considerable vacuity between petrosal and alisphenoid, suggestive of the Hystricomorph condition, but it may have been wholly covered in by the bulla.

In the lower jaw, the anterior border of the masseteric fossa is much further back than in Sciuridæ, mental foramen beneath  $p_4$ , diastema decidedly shorter than in any Sciurids, symphysis mandibuli extended backward along lower border of jaw to a point beneath  $m_1$ , the border being more or less angulate at this point. Coronoid process much longer and broader than in Sciuridæ (cf. *Aplodontia*); the angle (see Fig. 7) is a vertical plate, not inflected along its inferior border as it is to a varying extent among Rodentia generally (except Duplicidentata). The relation of the angle to the incisive alveolus is more like that of Sciuromorpha and Myomorpha than Hystricomorpha, but varies somewhat in the different species. In none does it show the marked lateral position of the angle characteristic of Hystricognathi, and in most species it may be said to arise entirely from the inferior border of the alveolus.

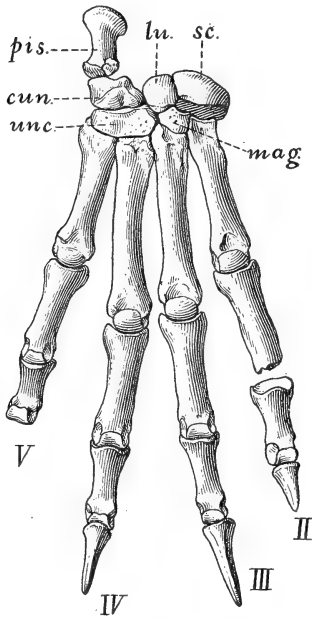


Fig. 4. *Paramys robustus*, fore foot, natural size, No. 13091.

The skeleton is proportioned much as in the larger squirrels, relatively larger than in *Arctomys*, especially in the hind limbs. The vertebræ are longer, especially in the cervical and lumbar regions, the lumbar spines much higher. The tail is very long and stout, much exceeding the presacral series in length, and the caudal vertebræ, beyond the first five or six, are much elongate. The limbs and feet are comparatively slender. The humerus has an entepicondylar foramen and no epitrochlear perforation. Its tuberosities are of the usual rodent type, the deltoid crest is strong and ends abruptly about the middle of the shaft. The head of the radius is round-oval. The ulnar shaft is broad and flat. The manus has four functional digits and a rudimentary pollex. Scaphoid, lunar and centrale are separate, and a radial sesamoid (pre-pollex) is present. The phalanges are long, the unguals<sup>1</sup>

<sup>1</sup> Excepting in the subgenus *Ischyrotomus* (infra).

sharp, high, compressed, not fissured at the tips, the penultimate phalanges somewhat asymmetric. The femur has a moderate third trochanter, set two fifths down on the shaft. The patellar trochlea is rather broad and shallow, patella flat and small, fabellæ well developed. Tibia and fibula separate, the latter comparatively well developed, its shaft equaling the metapodial shafts in size. Astragalus much like that of *Arctomys*, except for the less vertical depth of the head. The pes has five well developed digits, the first considerably shorter than the others. The phalanges are slender the penultimate series somewhat asymmetric, the unguals sharp and compressed, like those of the manus. Presence of a pre-hallux is not demonstrated.

*Species of Paramys.* Sixteen species of this genus have been described from the Wasatch, Wind River, Bridger, Washakie and Uinta formations. With two exceptions they are based upon parts of jaws or teeth. *P. sciurooides* Scott and *P. copei* Loomis are founded upon skull and jaws with parts of the skeleton. The genus embraces a wide range in size, and in the proportions and construction of the teeth, far wider than any modern Sciurid genus. It is a commendable custom, however, to draw generic lines much wider among extinct than among living species, on account of our imperfect knowledge of the fossil forms. I continue therefore to refer these species to *Paramys*, distinguishing the most aberrant ones as subgenera.

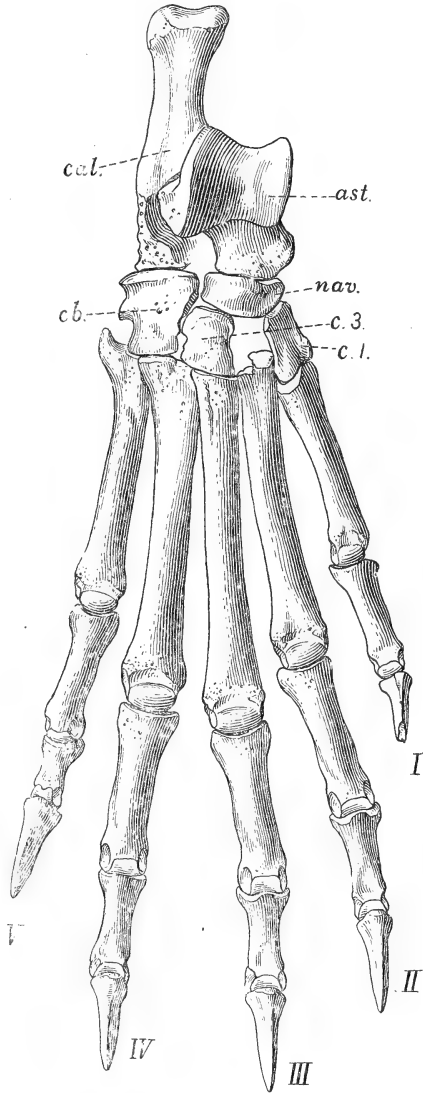


Fig. 5. *Paramys robustus*, hind foot, natural size, No. 13091.

The species may be grouped as follows:

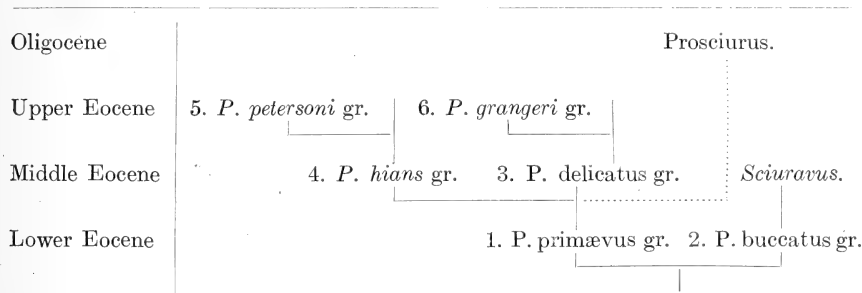
1. *P. buccatus* group. Very small, molars approaching *Sciuravus* in structure, sub-quadrate with well developed cusps, basins reduced. *P. buccatus* Cope, *atwateri* Loomis. Lower Eocene.
2. *P. primævus* group. Small species with low marginal cusps and broad shallow basins on the lower molars. *P. primævus*, *excavatus*, *quadratus*, *major* Loomis. Lower Eocene.
3. *P. delicatus* group. Medium sized species with cusps larger, basins deeper and smaller. Incisors moderately wide, with convex anterior faces. Symphyseal flange slight or none. Unguals high, compressed. *P. delicatus*, *delicatio*, *delicatissimus*, Leidy, *sciuroides* Scott, *copei*, *bicuspis* Loomis. Lower, Middle and Upper Eocene.
4. *P. hians* group. (subgenus *Pseudotomus* Cope). Large species with broad robust molars,  $p_4$  reduced, incisors very wide, convex anteriorly. Symphyseal flange deep. Unguals as in preceding group. *P. hians* Cope, *robustus* Marsh, ? *uintensis* Osborn, ? *superbus* O. S. & S. Middle and Upper Eocene.
5. *P. petersoni* group (subgen. nov. **Ischyrotomus**). Large species with molars as in preceding group,  $p_4$  reduced, incisors wide, flat anteriorly. Symphyseal flange deep. Unguals long, not compressed. *P. petersoni* infra. Upper Eocene.
6. *P. grangeri* group (subgen. nov. **Leptotomus**). Large species with molar cusps higher, basins further reduced,  $p_4$  not reduced, breadth of molars moderate; incisors narrower, compressed, convex anteriorly; no symphyseal flange; hind limbs relatively large; unguals high, compressed. *P. grangeri* infra, *leptodus* Cope. Upper Eocene.

Of the described species four are from the Wasatch, three from the Wind River, six from the Bridger, one from the Washakie and two from the Uinta formation. Two new species from the Uinta are here described. There would appear to be a good deal of individual variation in the teeth. The Lower Eocene species have recently been revised by Dr. Loomis; the Middle and Upper Eocene species have been reviewed for the present study, which however is not greatly concerned with species distinctions except as they relate to the morphology and evolution of the group. The species exhibit in general a successive approximation towards the sciurid pattern in the molars, from the Wasatch species with broad flat crowns and low marginal cusps, to those of the Uinta with higher cusps, reduced basins, and a tendency to cross-cresting. They vary widely in size, the largest equalling the Canada porcupine, the smallest not exceeding the red squirrel. The Wasatch species are all comparatively small. The teeth are readily interpreted as of the tritubercular pattern, with large heels on the lower molars. I find myself

quite unable to agree with Dr. Loomis (1907, p. 126, fig. 1) in his interpretation of the lower molars; the cusp which he calls paraconid is in my opinion the metaconid, and his metaconid the entoconid.

The relations of the several groups I take to be approximately as follows:

*Phylogenetic Relations of the Species of Paramys.*



*Wasatch Species.*

*P. buccatus* Cope, 1874.  $P_4-m_3 = 11$  mm. (calculated from the upper molars of the type). Loomis refers this species to *Sciuravus*, but Cope's description and figures appear to me to agree much better with *Paramys*.

*P. atwateri* Loomis, 1907.  $P_4-m_3 = 12.5$  mm. Like the preceding species this has some resemblance to *Sciuravus*. It is possibly a larger variety of *P. buccatus*.

*P. primævus* Loomis, 1907.  $P_4-m_3 = 15$  mm. This appears to be the common form of the Wasatch. Cusps low and marginal, basins broad and shallow. Individual variation wide, especially in size.

*P. quadratus* Loomis, 1907.  $P_4-m_3 = 18$  mm. Distinguished by larger size, and broader more robust teeth.

*Wind River Species.*

*P. copei* Loomis, 1907.  $P_4-m_3 = 13.5$  mm. The type of this species is the skull, jaws and part of skeleton described and figured by Cope in 'Tertiary Vertebrata' under the name of *Plesiarctomys delicatissimus*. Dr. Loomis distinguishes it from Leidy's species by the double anterior cusp of  $p_4$ , lower cusps and broader basins on the molars.

*P. bicuspis* Loomis, 1907.  $P_4-m_3 = 13.5$  mm. Distinguished from *P. copei* by the twinning of the mesostyle.

*P. major* Loomis, 1907.  $P_4-m_3 = 16.5$  mm. Distinguished from the

two preceding species by larger size, from *P. delicatior* by slenderer proportions, broader basins, and smaller cusps to the molars.

*P. excavatus* Loomis, 1907.  $P_4-m_3 = 12$  mm. A small species with broad basins and small marginal cusps, and wide incisors. Although typically from the Wind River, it is very like the smaller specimens of *Paramys* from the Wasatch.

### *Bridger Species.*

*P. delicatus* Leidy, 1871.  $P_4-m_3 = 19$  mm. This is the type of the genus, and is represented by abundant material in our collections. I refer to it several skeletons more or less complete, the best being No. 12506, skull, lower jaw, all the vertebræ except two dorsals and a few distal caudals, one fore limb and both hind limbs; No. 13090, skull with most of fore and hind limbs, various vertebræ, etc.; No. 11593, skull, parts of lower jaw, limb bones, etc.; and some twenty upper and lower jaws, parts of skulls and other fragmentary material. All of these are from the lower or middle beds, the highest level being the top of Horizon C. The specimens from the middle beds (Horizon C), show a slight reduction of  $p_4$  in comparison with those of Horizon B, and the cusps are a little more robust, the central basin reduced.

The more important characters are stated under the generic description. The specific characters are as follows:

Skull about as large as in *Arctomys monax*, body more elongate, especially in cervical and lumbar regions, tail nearly four times as long. Fore limbs about a tenth longer, hind limbs about a third longer than in *A. monax*. Femur and tibia of equal length. The entire length of the animal was about a meter, of which more than half was tail. The proportions run much as in the larger squirrels, but the skull is much more like that of a woodchuck. The comparatively long neck and slender body, long tail, slender feet with sharp claws, all agree most nearly with arboreal animals, and, like the teeth, are most nearly comparable with the large tropical squirrels. Loomis regards *Paramys* as terrestrial, but it is in my opinion unmistakably adapted to an arboreal habitat.

*Principal measurements* (see also table of comparative measurements):

Length of skull	89.
7 cervical vertebræ	60.
12 dorsal " , est'd (10 preserved measure 113 mm.)	137.
7 lumbar "	133.
3 sacral "	42.
229 caudal " , est'd (24 preserved in series, 473 mm.)	540.
Total length of skeleton including tail, est'd	1001.
Fore limb. Length (phalanges estimated)	215.
Hind limb, length	296.
Hind foot, length	104.

*P. delicatior* Leidy, 1871.  $P_4-m_3 = 15.3$  mm. This is the most abundant species of the Bridger, about three fourths of our specimens being referable to it. All are upper and lower jaws, except for certain unprepared skeletons provisionally placed here. It is closely allied to *P. delicatus* and



Fig. 6. *Paramys delicatus*, restoration of skeleton, one-fourth natural size. Shaded portions from No. 12506, outlined portions from other specimens of *Paramys*, dotted outlines adapted from the modern squirrel. Drawn by Erwin Christman.

separable in the dentition only by smaller size and somewhat more slender proportions. The infraorbital foramen of the skull is distinctly smaller in proportion.

*P. delicatissimus* Leidy, 1871.  $P_4-m_3 = 12.6$ . This small species is rather scarce and not well represented in our collections. The jaw is more slender, the diastema less deeply notched, the incisor relatively more compressed.

*P. robustus* Marsh, 1872.<sup>1</sup>  $P_4-m_3 = 22.5$ . The type of this species is stated to consist of two lower molar teeth,  $m_{2-3}$ . Other fragmentary specimens are referred by Marsh to the species, including a lower incisor. Three specimens in our collection agree with Marsh's type, so far as the published

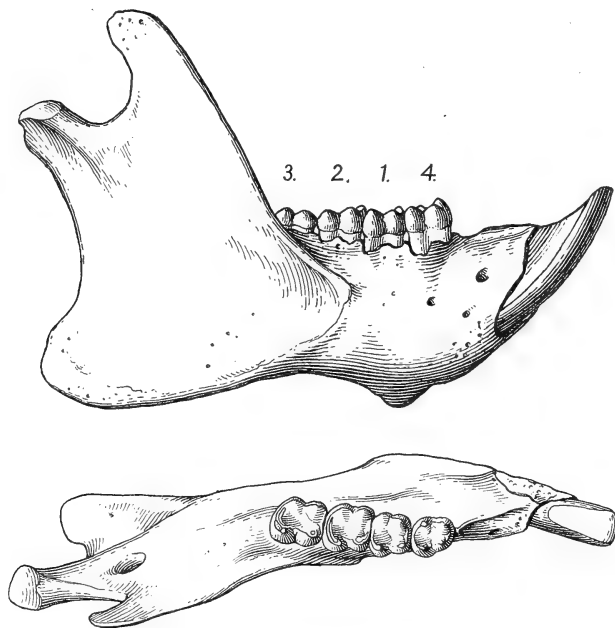


Fig. 7. *Paramys robustus*, lower jaw, natural size, external and superior views. No. 13091. Lower Bridger, Wyoming.

description and measurements permit comparison. Of these, two are lower jaws, the third, no. 13091, is a skeleton, incomplete, but finely preserved. This specimen (Figs. 4, 5 and 7) includes three upper teeth, a complete lower jaw, scapula, pelvis, and both fore and hind limbs practically complete, many of the presacral and caudal vertebræ, and numerous fragmentary ribs, etc.

The species is very clearly distinct from *P. delicatus*. The teeth are larger, much broader,  $p_4$  proportionately shorter and smaller, the jaw much

<sup>1</sup> Amer. Jour. Sci., Vol. iv, p. 218 (separata issued August 17).



deeper with the symphysis extended backward and downward in a prominent flange on the inferior margin beneath  $m_1$ . The antero-inferior border of the masseteric fossa is much more prominent, and shows a suggestive approach toward the hystricomorph construction of the angle. The angle lies wholly in a vertical plane, lacking the inflection of the inferior border characteristic of most modern rodents. The coronoid process is large, high and broad.

The skeleton indicates an animal nearly as large as the American beaver, but of different proportions, much like the larger squirrels, and agreeing closely with *P. delicatus* except for the more elongate lower limbs and feet. The more important skeleton characters have been noted in the generic

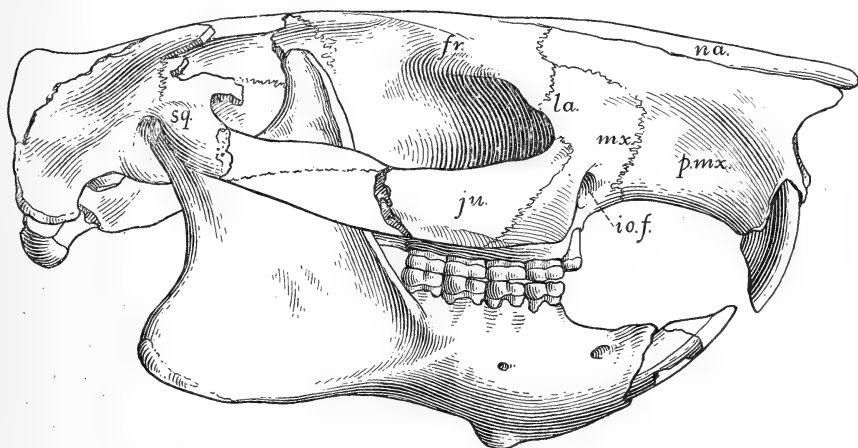


Fig. 8. *Paramys (Ischyrotomus) petersoni*, skull and lower jaws, No. 2018, type specimen, natural size. Telmatotherium beds of Uinta Basin, Utah.

description. The total length of this species must have been about four feet, half of this being tail.

*P. hians* (Cope, 1872). Type, a skull, No. 5025, Am. Mus. Cope Coll., considerably crushed and lacking the cheek teeth, top of braincase and zygomata. It is distinguishable from *P. robustus* by the much broader incisors, no other comparisons being practicable. No referred specimens in our collections. *Paramys superbus* O. S. and S., 1877, known only from a part of a lower incisor, may be identical with *P. hians*.

This species is the type of *Pseudotomus*, which may prove to be a valid genus, or at least generically distinct from *Paramys* if not from *Plesiarcotomys*; but until better direct evidence appears, it may be regarded as a subgenus. *P. robustus* is much better known, but appears to be an annectant form with *Paramys* s. s., although nearer to *P. hians*.

*Washakie Species.*

*P. leptodus* Cope, 1872.  $P_4-m_3 = 21$  mm. This species, type No. 5026, a lower jaw from the Upper Washakie, is considerably larger than *P. delicatus*, but with a slender narrow incisor. The molar cusps are more prominent, the basins of the teeth more reduced. The heel of  $m_3$  is not so broad and quadrate as in the Bridger species, and the entoconid is placed further forward. *P. grangeri* (infra) is a closely related species of somewhat larger size.

*P. cf. delicatus* Leidy. A specimen from the Lower Washakie, No. 13215, parts of jaws and fragments of skeleton, agrees quite nearly with this Bridger species.

*Uinta Species.*

*P. sciuroides* (Scott, 1887).  $P_4-m_3 = 12$  mm. This is one of the smallest species of the genus. The type is a well preserved skull and jaws with parts of the skeleton in the Princeton Museum. Professor Scott has pointed out certain approximations in the dentition to *Sciurus* as compared with the older forms.

*P. uintensis* Osborn, 1895. A much larger species, comparable in size and characters with *P. robustus*, but no satisfactory comparison of the two can be made on account of the fragmentary nature of the types. The type of *P. uintensis*, Am. Mus. No. 1901, consists of  $m^{1-2}$ ,  $m_2$  and an incomplete lower incisor. No referred material.

*P. petersoni* sp. nov.  $P_4-m_3 = 23$  mm. Type, No. 2018, Am. Mus., a skull, jaws and partial skeleton found by O. A. Peterson in the Telmatotherium level in 1895. It is a little larger than *P. hians* of the Bridger, and may be distinguished by the much longer skull, narrower incisors, longer diastemata, etc. It is the largest species of the genus. Teeth broad and robust as in *P. hians* and *robustus*, muzzle peculiarly angular. Anterior face of lower incisors

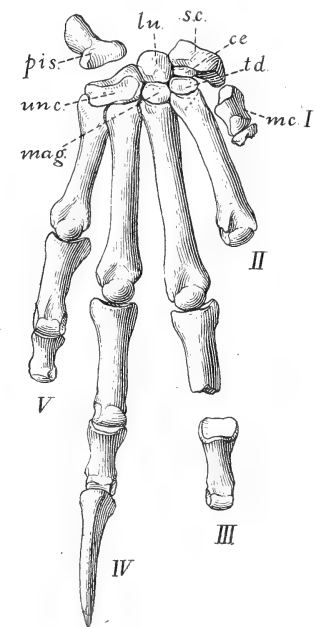


Fig. 9. *Paramys* (*Ischyrotomus*) *petersoni*, fore foot, natural size, type specimen.

flat, as in *Castoridae*, *Geomyidae*, etc., a marked distinction from any other species of this genus.

The greater part of the skeleton is preserved in the type, but has not yet been prepared. The proportions of the fore and hind limbs are much as in *P. delicatus* and *robustus*, but the entire skeleton is smaller in proportion to the size of the skull. The manus shows four functional digits, a short, stout pollex and a radial sesamoid (pre-pollex). The unguals are of very different type from those in *P. delicatus*, *robustus* or *grangeri*; they are long, uncompressed, nearly round in cross section, little curved, and evidently specialized for fossorial habits. Scaphoid, lunar and centrale separate, digits somewhat shortened from the proportions of the other species.

*P. grangeri* sp. nov.

$P_4-m_3 = 23$  mm. Type, Am. Mus. No. 2016, a lower jaw with fragmentary skeleton, from the top of the Telmatherium Beds, found by Walter Granger in 1895. This species is closely related to *P. leptodus* of the Washakie, but larger and more robust. The incisor is narrow, slender, longer and more procumbent than in the *P. delicatus* group, and much more compressed. Diastema longer, molars less basined, the enamel not rugose. Entoconid of  $m_3$  more anterior, hypoconid more postero-medial in position, connecting crests between protoconid and hypoconid generally more prominent.  $P^4$  more trigonal in outline, metaconule more prominent than metacone.

$P_4-m_3$  one tenth longer than in *P. leptodus*, the molars one fourth to one sixth wider.

A second specimen found by Mr. Granger in 1906 in the Upper Washakie, is referable to this species. It consists of lower jaw,  $p^4$  and fragments of skeleton.

The limb bones in *P. grangeri* are more robust than in *P. delicatus*, and the proportionate size of the hind limb is considerably greater. The scaphoid and lunar of the left side in the type specimen are united, those of the right side separate; this probably indicates a tendency to fusion of the two bones. The centrale

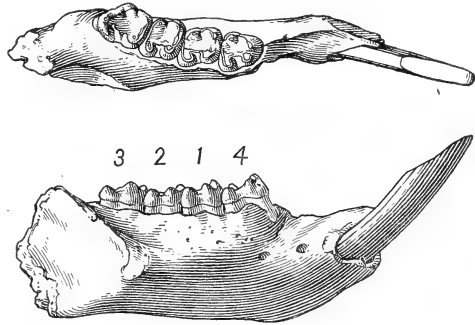


Fig. 10. *Paramys (Leptotomus) grangeri*, lower jaw, superior and external views, natural size. Type specimen, No. 2016, Uinta beds, Utah.

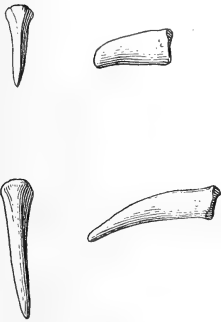


Fig. 11. Claw phalanges of fore foot in *P. grangeri* (upper) and *P. petersoni* (lower), natural size, dorsal and lateral views.



remains separate, as usually among rodentia. The fore-foot is somewhat more elongate than in *P. delicatus*, the ungual phalanges are of similar type but less compressed. The hind limb is one third larger throughout than in *P. delicatus*, and of more robust proportions.

### *Sciuravus* Marsh, 1871.

*Sciuravus* MARSH, 1871, Amer. Jour. Sci., Vol. II, p. 122. Separata issued July 1871.

*Plesiarctomys* (in part) COPE, 1884. Not of Bravard.

*Paramys* (in part) ZITTEL, 1893; MATTHEW, 1899; HAY, 1902. Not of Leidy.

*Sciuravus* LOOMIS 1907, MATTHEW 1909.

This was the first genus of rodents described from the American Eocene, but on account of the brief and inadequate description has been mostly confounded with the better known *Paramys*, which, however, it antedates by about five months. Loomis in 1907 showed that the genera were distinct.

*Sciuravus* is nearly related to *Paramys*, but includes smaller species with quadritubercular upper molars. The dental formula,  $\frac{1.0.2.3}{1.0.1.3}$ , is the same as

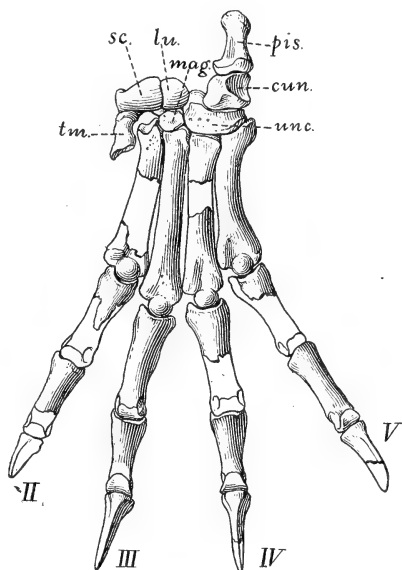


Fig. 12. *Paramys* (*Leptotomus*) *grangeri*, fore foot, natural size. No. 2016, Type.

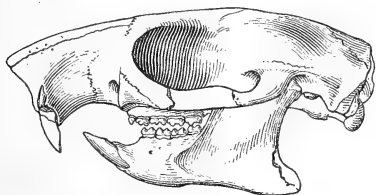


Fig. 13. *Sciuravus nitidus*, skull and lower jaw, side view, natural size, No. 12551. Lower Bridger, Wyoming.

in *Paramys* and the general proportions of the teeth much the same as in the small species of that genus. The protocone and hypocone of the upper molars are distinct, well separated, sub-equal. In the lower molars the entoconid is placed further forward, and a strong ridge from the hypoconid runs inward behind it along the posterior margin of the tooth. This ridge may be compared in position with the hypoconulid, but is doubtfully homologous with the hypoconulid of other orders, and is well marked on all the molars. The molar cusps are more distinct than in *Paramys*, the basining of the crown less apparent. The pattern is a marked approach toward those of *Ischyromys* and *Gymnoptychus* (= *Adjidaumo*).

The skull is very like that of *Paramys* except for a longer muzzle, more slender proportions, and absence of sagittal crest. In size and general proportions it compares with the rat (*Mus decumanus*). The tympanic bulla is incompletely ossified and loosely attached to the skull; it has no tubular meatus, the ossification comprising little besides the tympanic ring. What is known of the skeleton agrees with *Paramys* except for the lesser width of the distal end of the humerus. The carpals and the number of digits are unknown.

No satisfactory revision of the species can be undertaken without a re-study of the types of this and allied genera which at present I know only from Marsh's descriptions. Our material, provisionally referred to the genus

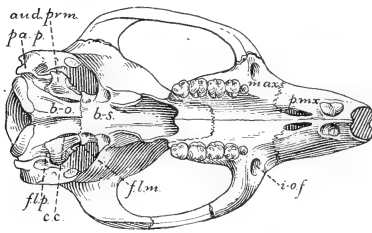


Fig. 14.

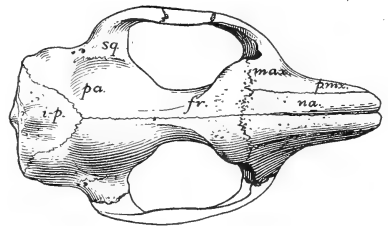


Fig. 15.

Fig. 14. *Sciuravus nitidus*, under view of skull, natural size, No. 12551. *Aud. prm.*, auditory prominence; *pa.p.*, paroccipital process; *f.b.-o.*, basioccipital; *b.-s.*, basisphenoid; *c.c.*, carotid canal; *f.l.m.*, foramen lacerum medium; *f.l.p.*, foramen lacerum posterius; *i.o.f.*, infra-orbital foramen.

Fig. 15. *Sciuravus nitidus*, top view of skull, natural size, No. 12551.

and identified through the courtesy of Dr. Loomis, consists of two nearly complete and several incomplete skulls, with fragmentary skeletons associated, and numerous upper and lower jaws.

### ***Mysops* Leidy, 1873.**

A smaller animal than *Sciuravus*, with narrower teeth, upper molars less quadrate, the inner cusps less distinctly separate, the centre of the crown more basined. Lower molars narrower, the anterior pair of cusps higher and more crested, the entoconid more central in position. Construction of antorbital region as in *Sciuravus* and *Paramys*.

The genera *Tillomys*, *Taxymys* and *Colonomys* Marsh are known only from fragments of jaws or separate teeth, and Marsh's brief descriptions do not satisfactorily separate them from *Sciuravus*. The smaller referred species of *Tillomys* is perhaps identical with *Mysops*.

***Ischyromys* Leidy, 1856.**

The structure of the skull in this genus has been described and figured by Leidy and Cope. It has the same primitive construction of the ant-orbital region as in *Paramys*, *Sciuravus* and *Mysops*, save that the infra-orbital foramen is somewhat larger, and its anterior opening faces somewhat more downward. This direction appears to preclude its transmitting any portion of the median masseter, nor is there any evidence of the attachment of the muscle to the surface of the bone in front of or above the foramen. The characters of the antorbital region are throughout closely comparable with *Aplodontia*. The tympanic bullae are large, completely ossified, and always attached to the skull, unlike the Eocene genera. The attachment of the masseter on the lower jaw is limited anteriorly as in *Paramys*, the anterior

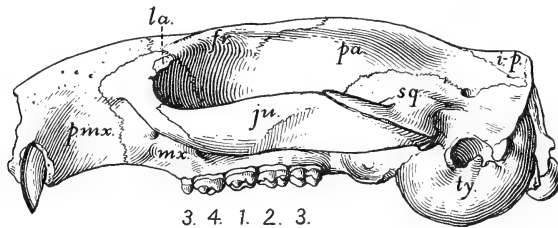


Fig. 16. *Ischyromys typus*, skull, natural size, Oreodon beds, S. Dakota. No. 694.

border of the masseteric fossa extending forward only to a point beneath  $m_2$ . The mental foramen is further forward than in *Paramys*, not so far as in *Arctomys*.

The skeleton of this genus is almost completely determinable from specimens in our collections, but in their present state of preparation the characters can be only partially stated. The cervicals are much shorter than in *Paramys*, not as short as in *Arctomys*. The tail was long and heavy. The humerus has an entepicondylar foramen and a prominent deltoid crest produced into a distinct process. The breadth of the ulnar shaft is intermediate between *Paramys* and *Arctomys*. The third trochanter of the femur has the same position as in *Paramys*; in *Sciuridae* it is higher up on the shaft.

The dentition is a direct derivative of that of *Sciuravus* by partial conversion of its cusps into transverse crests.

SPECIES OF *Ischyromys*.

A. *Ischyromys* s.s. Incisors of moderate width, muzzle heavy and deep, skull with low sagittal crest, arches moderately deep, no masseter attachment on side of muzzle.

1. *I. typus* Leidy, 1856. Oreodon Beds, South Dakota and elsewhere. Length of skull, incisors to condyles, 63 mm. Teeth wider transversely with lower crowns and heavier enamel.

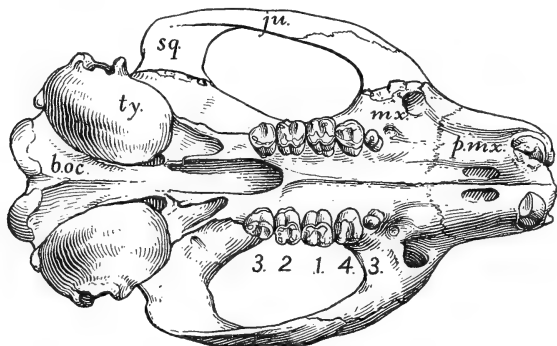


Fig. 17. *Ischyromys typus*, under view of skull, natural size. No. 694, Oreodon Beds, S. Dakota.

2. *I. cristatus* (Cope, 1872). Syn., *Gymnoptychus chrysodon* Cope, 1872. Oreodon Beds, N.-E. Colorado. Teeth narrower transversely

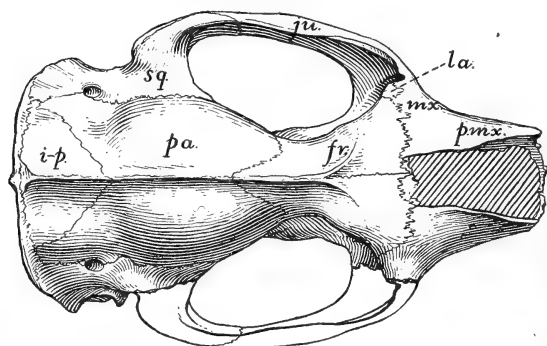


Fig. 18. *Ischyromys typus*, top view of skull. No. 694.

than in *I. typus*, with higher crowns and thinner enamel; skull and teeth usually smaller and sagittal crest sometimes incomplete anteriorly.



B. **Titanotheriomys**, new subgenus. Incisors narrow, muzzle small, no sagittal crest but an indistinct lyrate area; zygomata slender, superior border of origin of masseter extended forward on muzzle in an indistinct ridge.

3. *I. (T.) veterior* Matthew, 1903. Length of skull, incisors to condyles, 54 mm. Cheek-teeth much as in *I. cristatus* but heel of  $m_3$  narrow with incomplete crest.

The skull proportions of this last species, as determined from a fragmentary skull from the type locality (Pipestone Springs, Montana) and a skull and skeleton (No. 14579) from the Titanotherium beds of Wyoming, differ so widely from the typical *Ischyromys* that I am obliged to place it in a separate subgenus. It belongs to a distinctly older horizon than *I. typus* or *cristatus* and is in some respects more primitive, but in the antorbital construction shows a definite advance towards the Sciurid type.

#### **Prosciurus** Matthew, 1903.

In the description of *Sciurus (Prosciurus) vetustus* from the Lower Oligocene, I stated that these earlier Oligocene squirrels were probably generically distinct from any modern sciurids, although the distinctions then observed did not warrant separating them as more than a subgenus. Review of the White River material, somewhat augmented since that date, shows additional characters which certainly warrant raising *Prosciurus* to the rank of a distinct genus, and apparently it should be included in the Ischyromyidae rather than the true Sciuridae. The anterior margin of the masseteric fossa is under  $m_2$  as in *Paramys*, *Ischyromys*, etc., instead of under  $p_4$  or  $m_1$  as in Sciuridae. This appears in the types of *S. relictus* and *vortmani* Cope and in two undescribed jaws from the White River. The relations of the infraorbital foramen in the type of *S. vetustus* were apparently as in the Ischyromyidae and certainly not as in the Sciuridae. From these indications I judge that these species retained the primitive construction of the antorbital region. *Sciurus ballovianus* Cope, from the John Day, appears, on the other hand, to have assumed, at least in part, the true Sciurid conditions in this region, so far as may be judged from the imperfectly preserved skull. I leave it therefore in the modern genus, and transfer the other three species under *Prosciurus*, to the Ischyromyidae. The Miocene squirrels, known only from a few jaws, appear to be true Sciurids, as are *S. chalaniati* and *feignouxii* of the Upper Oligocene of Europe.

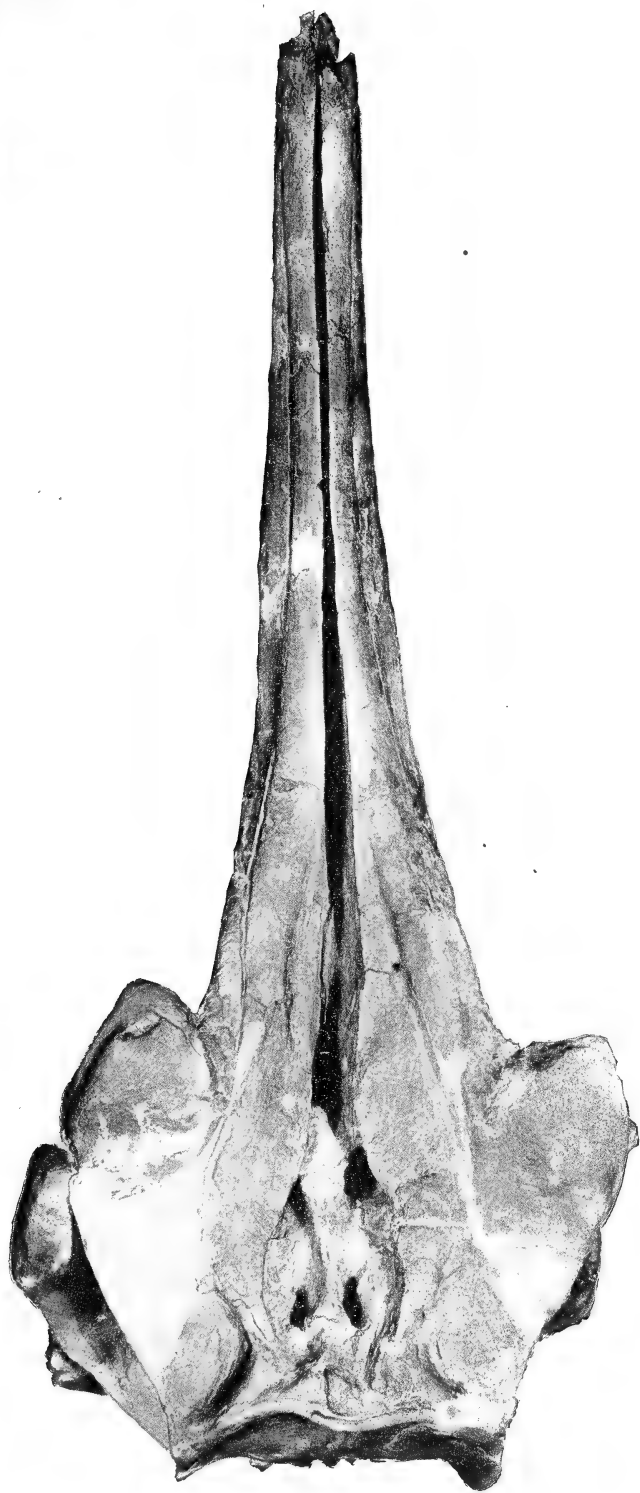
**Cylindrodon** Douglass, 1901.

This genus appears also to exhibit the primitive construction of the ant-orbital region, so far as can be judged from the upper jaw figured by me in 1903, and should apparently be separated from the Castoridæ on this ground, while from the Ischyromyidæ it is distinguished by the dental formula. The fundamental pattern of the molars is apparently much as in *Stenofiber*, but it is also quite near to certain of the Theridomyidæ, with which it agrees better in what little is known of the antorbital region, except that the antorbital foramen is small, while in the European family it is said to be large. There is no tendency towards the Hystricomorph construction of the angle such as is observable in several of the Theridomyid genera. None of the Ischyromyidæ come near *Cylindrodon* in tooth-pattern. It may best be referred provisionally to the Ischyromyidæ.

## AFFINITIES OF THE ISCHYROMYIDÆ.

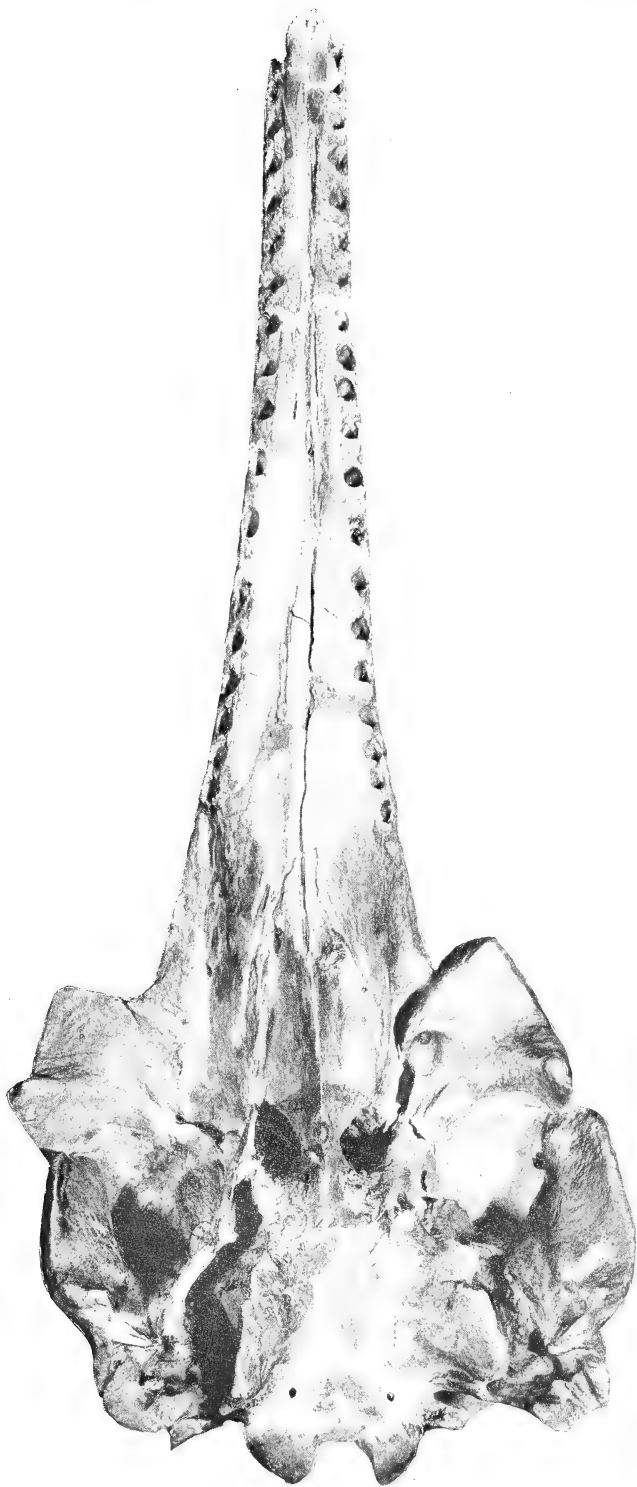
From their geological position we should expect this family to be more or less directly ancestral to the later groups of rodents and to represent the common stock from which they have differentiated. This appears to be substantially the case, so far as the Simplicidentata are concerned. They give little or no hint as to the ancestry of the Lagomorpha, which are not included in the following discussion.

The structure of the antorbital region in the Ischyromyidæ must be regarded as the primitive construction among the rodentia generally. It agrees most nearly with the construction in other orders of mammalia, especially the more primitive mammals. In nearly all modern rodents the masseter is extended forward so as to gain a strong attachment on the side of the muzzle in advance of the orbit, thus giving it increased leverage on the incisors. In the Sciuomorpha (except *Apodonta*), the *external* portion of the masseter is extended forward *above* the infraorbital foramen, which is small, and opens considerably in front of the zygoma and low down on the muzzle. In the Hystricomorpha the *inner* portion of the masseter is extended forward *through* the infraorbital foramen, which is much enlarged and faces more upward. In the Myomorpha the *external* part of the masseter is extended forward on a plate projecting from the root of the zygoma and *overlapping* the infraorbital foramen, partially dividing it into two unequal parts, of which the small lower division transmits the nerve, while a part of the *inner* portion of the masseter is extended forward through the large upper division of the foramen to gain an attachment on the side of the skull.



SKULL OF *DIOCHOTICHUS VANBENEDENI*.





SKULL OF DICCHOTICHUS VANBENEDENI.





1



2

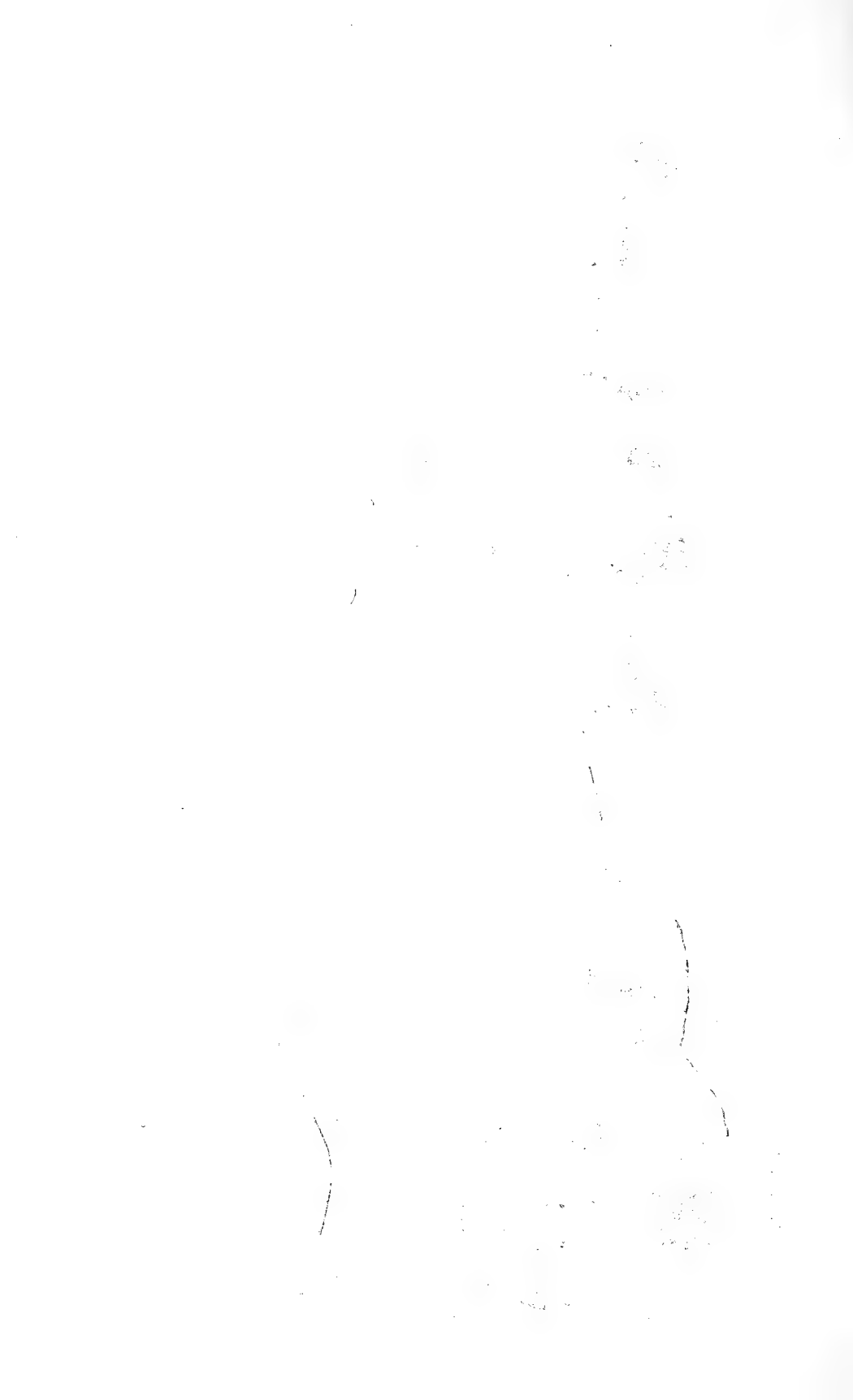


3



4

SKULL AND EARBONES OF *DIOCHOTICHUS VANBENEDENI*.







1



2

3

4

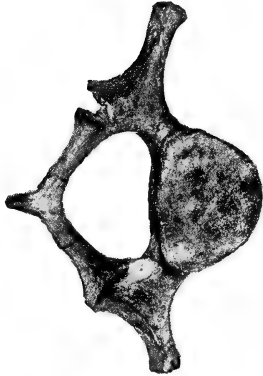
SKULL AND RIBS OF *DIOCHOTICHUS VANBENEDENI*.



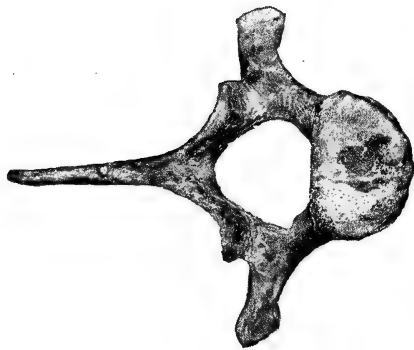
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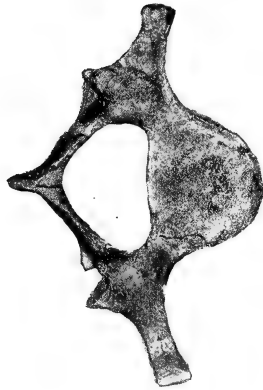
8



1



3



5



7



VERTEBRE OF *DIOCOTICHUS VANBENEDENI*.



This forward extension of the masseter is carried furthest in the most progressive members of the three principal groups of Simplicidentate rodents. The primitive condition is universal in the Eocene, common in the Oligocene, rare in the Miocene, and among modern rodents is preserved only in a few aberrant and exceptional types, most perfectly in *Aplodontia*.

In the lower jaw the Ischyromyidæ are likewise unmistakably primitive. They retain the vertical uninflected angle characteristic of most placental mammals, but rare among rodents. In nearly all modern rodents the angle is inflected or twisted by the hypertrophy of certain parts associated with the specialization of the masseter. In most of the Hystricomorpha, and in the Bathyergidæ, the antero-inferior border of the masseteric fossa is raised into a prominent ridge projecting outward, so that the angle appears to originate anteriorly from the external side of the incisive alveolus. In the Sciuromorphs and Myomorphs this does not occur, but the postero-inferior border of the masseteric fossa, as also in some Hystricomorphs, is extended and inflected, while the posterior point of the angle is more or less everted. The primitive condition is most nearly retained in this respect among the Muridæ — *Aplodontia* is highly specialized — the Sciuridæ less so. The masseteric fossa is also considerably extended anteriorly in most modern rodents, and the coronoid process reduced (except in *Aplodontia*).

The imperfectly ossified bulla, short backwardly directed paroccipital process, posterior extension of the nasals and premaxillaries, narrow post-orbital constriction, etc., are all primitive Eutherian cranial characters, common to nearly all Eocene mammals, generally or always lost in modern rodents, as they are to a varying extent in other orders.

The dentition of the Ischyromyidæ is that of the Sciuridæ and Aplodontiidæ, the most primitive of modern rodents in this respect. The skeleton agrees in proportions and construction with the arboreal squirrels, but retains one primitive character lost in all modern rodents except *Bathyergus*, the separate lunar and scaphoid of the carpus. The feet are very sciuroid, and while they are the most generalized rodent feet, they show the distinctive characters of the order already firmly fixed, in the peculiar reduction of the pollex, presence of radial sesamoid, characteristic form of astragalus etc.

The varying construction of all modern rodents in teeth, skull and skeleton can readily be derived in all details from the Eocene Ischyromyid type. They have undergone a great variety of parallel and divergent changes of reduction and specialization of parts, in adaptation to their various terrestrial, cursorial or amphibious habits. The adaptations in the masseter muscle and its attachments offer an obvious case of parallelism with analogous structural changes in the several groups. The perfecting of the

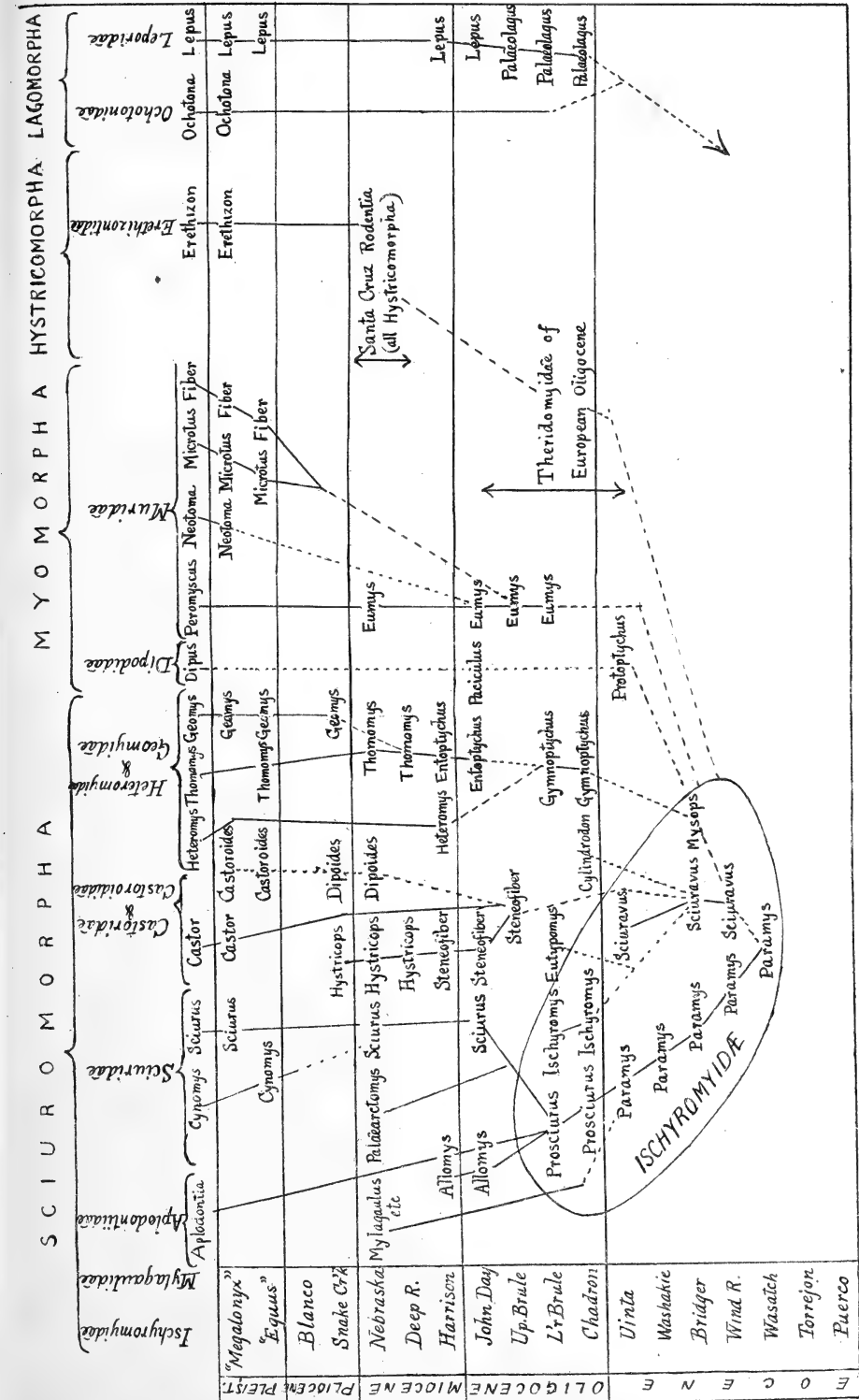
bullae, its peculiar specializations in certain groups, the increase in brain capacity, with consequent broadening of the cranium, reduction of sagittal crest, widening of postorbital constriction, change in the position and direction of the paroccipital, and numerous minor changes in the skull, afford instances of much closer parallelism, with homologous structural changes in the several groups.

The teeth of modern rodents show a great variety of both parallel and divergent evolution as compared with *Ischyromyidae*. In the *Hystricomorphs*  $p^3$  is lost and the crowns of the teeth are lengthened to a varying extent, and their pattern complicated in various ways. In the *Myomorpha*  $p^3$  is always and  $p^4$  usually lost, and in the higher groups the crowns are lengthened and their pattern complicated. In the *Castorids*  $p^3$  is lost and the crowns lengthened and complicated, in the *Geomysids* and *Heteromyids*  $p^3$  is lost and the crowns much elongate, but the pattern becomes simpler. The *Sciurids* and *Aplodontiidae* retain the primitive dental formula, the former retaining more nearly the brachyodont teeth, especially in the *Sciurinae*.

The limbs and feet in the *Hystricomorphs* show a great variety of reductions and specializations, but the group appears to have been primarily characterized by short limbs and short broad feet with a tendency to tridactylism. The *Myomorphs* have one peculiar progressive feature, the consolidation of tibia and fibula, but are mostly conservative in foot structure. The *Sciurormorphs* include some very primitive types, and others that are highly specialized. Fossorial, cursorial and saltatorial adaptations appear in each group, and afford instances of fairly close parallelism.

It will be observed that the most primitive rodents, except in the features conditioned by brain evolution, are the arboreal types. This is wholly in accord with the evidence from other groups, in supporting the theory which I advanced some years ago that all mammals are derived from arboreal ancestry.

The most primitive European rodents, the *Theridomyidae* and *Pseudo-sciuridae*, although imperfectly known, approach very nearly to the *Ischyromyidae*, but appear to be transitional in several respects between this family and the *Hystricomorpha*. The antorbital region agrees with *Ischyromyidae* except for the somewhat larger size of the infra-orbital foramen, which also faces forward instead of partly downward, so that it could, and according to Zittel (1893) did transmit a branch of the masseter, as in *Myomorphs* and *Hystricomorphs*. They agree with *Hystricomorpha* in dental formula, and several of the *Theridomyidae* show a marked approach in tooth pattern toward certain *Hystricomorph* families, and also a very noticeable prominence of the antero-inferior border of the masseteric fossa, the jaw being otherwise constructed as in *Ischyromyidae*. This feature may



PHYLOGENY OF NORTH AMERICAN FOSSIL RODENTS  
Showing the Geological and Phylogenetic Relationships of the *Ischyromyidae*.

Fig. 19.

fairly be interpreted as prophetic of the Hystricomorph construction of the angle.

It is, however, open to very serious question whether the differences of these two groups from the Ischyromyidæ are any greater than may be found among different members of some of the modern families of the Rodentia, and their retention as distinct families should be regarded rather as a matter of convenience in classification than as indicating any very wide structural differences.

#### CLASSIFICATION.

The Ischyromyidæ are included in the Sciuromorpha by definition, as the infraorbital foramen does not transmit any portion of the masseter, and they are undoubtedly most nearly allied in nearly all structural features to the modern Sciuridæ. They are sharply separated however from the Sciuridæ, Castoridæ, Castoroididæ, Geomyidæ and Heteromyidæ by the primitive construction of the antorbital region, agreeing with the Aplodontiidæ and Mylagaulidæ in this respect. This distinction was sharply marked as far back as the Oligocene, for the Upper Oligocene *Sciuri* (*S. ballovanus*, *feignouxii*, *chalaniati*), and the Oligocene genera *Eutypomys* and *Steneofiber* (Castoridæ), *Gymnoptychus* (Heteromyidæ), and *Entoptychus* and *Pleurolicus* (Geomyidæ), are completely modernized in their antorbital construction, and no intermediate forms are at present known.<sup>1</sup> In view of the importance which the characters of this region assume in the classification of rodents, and of the antiquity of this distinction among the Sciuromorpha I think it should be the primary basis of division in this group of the order.

The Theridomyidæ and Pseudosciuridæ, on the other hand, although so closely resembling Ischyromyidæ as hardly to merit family distinction, must be referred to the Hystricomorphs (if we include the Anomaluridæ in this group) by definition, and the first family at least, apparently has true Hystricomorph affinities, and must be regarded as approximately ancestral to the group, despite the serious difficulties in accounting for the geological and geographical distribution of the known members of Theridomyidæ and Hystricomorpha.

The interesting Uinta genus *Protoptychus* appears to be, as shown by Scott, of Myomorph affinities, but far from typical, related and possibly ancestral to the Dipodidæ, but with marked indications of affinity to the Geomyidæ and Heteromyidæ as well. It is perhaps an annectant form between Sciuromorpha and Myomorpha. *Eumys* of the Middle and Upper Oligocene is unmistakeably and typically Myomorph and quite nearly

<sup>1</sup> *Sciurus ballovanus* and *Ischyromys veterior* (see p. 63 supra) are possible exceptions to this statement.



related to the Cricetinae, with which it agrees well in skull structure as well as in dentition. True Hystricomorpha are unknown in North America until the Pleistocene, the nearest possible approach being *Cylindrodon*, whose provisional position in the Ischyromyidae is rather a matter of convenience in classification than of actual affinity. Typical Myomorpha first appear here in the Middle Oligocene, while the typical Sciuromorpha have developed and differentiated out of the primitive group by the beginning of the Oligocene.

The Sciuromorph families may be defined as follows:

*Sciuromorpha* Brandt: Infraorbital foramen small, not traversed by masseter. Antero-inferior border of masseteric fossa little or not at all crested. Dentition  $\frac{1.0.2-1.3-2}{1.0.1.3-2}$ .

A. *Aplodontiidea* Gill, 1872: Infraorbital foramen moderately small, sub-circular, close to lower margin of orbit, origin of masseter wholly behind and below it, and not extended forward upon the side of the muzzle.

1. *Ischyromyidae* Alston, 1876. Teeth  $\frac{1.0.2.3}{1.0.1.3}$ , short-crowned. Skull of moderate width, no postorbital process, zygomatic arch moderately deep, angle uninflected. Arboreal and terrestrial, Lower Eocene to Oligocene. Genera *Ischyromys*, *Paramys*, *Sciuravus*, *Mysops*, *Prosciurus*.

2. *Mylagaulidae* Cope, 1881. Teeth  $\frac{1.0.1.2}{1.0.1.2}$ , premolar enlarged, hypsodont; molars reduced and caducous,  $m_1$  absent except in milk dentition. A postorbital process on frontal; zygomatic arch deep; skull wide posteriorly, posterior border of angle greatly inflected and posterior end everted. Nasals with or without bony horncores. Fossorial, Middle Miocene to Lower Pliocene. Genera *Mylagaulus*, *Ceratogaulus*, *Epigaulus*, *Mesogaulus*.

3. *Aplodontiidae* Thomas, 1897. Teeth  $\frac{1.0.2.3}{1.0.1.3}$ , progressively hypsodont, with prominent mesostyles and metastylids. No postorbital process; zygomatic arch slender; skull wide posteriorly; postero-inferior portion of angle greatly inflected, posterior end everted. Fossorial, Oligocene to recent. Genera, *Aplodontia*, *Meniscomys*, *Mylagaulodon*.

B. *Sciuroidea* s. l.: Infraorbital foramen small, compressed, anterior in position; origin of masseter extended forward upon the side of the muzzle above and behind the infraorbital foramen, limited superiorly by a prominent crest extending forward and upward from the anterior margin of the orbit. Includes three groups regarded as superfamilies by most modern systematists.

1. *Sciuridæ*. Teeth  $\frac{1.0.2-1.3}{1.0.1.3}$ , short crowned and tubercular. Post-orbital processes on frontals; skull of moderate width, arches slender to moderate, posteroinferior border of angle moderately inflected. Mastoid not inflated, auditory meatus short. Arboreal, terrestrial and fossorial. Oligocene to recent. Genera, *Sciurus*, *Palæarctomys*, *Arctomys*, *Cynomys*, *Pteromys*, *Sciuropterus*, *Tamias*, *Spermophilus*, and many others.
2. *Castoridæ* (and *Castoroididæ*). Teeth  $\frac{1.0.1.3}{1.0.1.3}$ , progressively hypsodont, with transverse enamel inflections (typically three external and one internal above, reversed below). No postorbital process; zygomatic arch deep; mastoid not inflated, auditory meatus long. Fossorial and amphibious, Oligocene to recent. Genera, *Castor*, *Steneofiber*, *Chalicomys*, *Trogontherium*, *Dipoides* (syn. *Sigmogomphius* and *Eucastor*), *Castoroides*, ? *Eutypomys*.<sup>1</sup>
3. *Geomyidæ* (and *Heteromyidæ*). Teeth  $\frac{1.0.1.3}{1.0.1.3}$ , progressively hypsodont with one, finally no transverse inflection. No postorbital process. Mastoid inflated, meatus long. Fossorial (*Geomyidæ*) and saltatorial (*Heteromyidæ*), Oligocene to recent. Genera, *Geomys*, *Thomomys*, *Entoptychus*, *Heteromys*, *Gymnoptychus*, *Heliscomys*, *Dipodomys*, *Perognathus*, etc.

The geological distribution of the North American fossil rodents is given in the following table, so far as known to me:

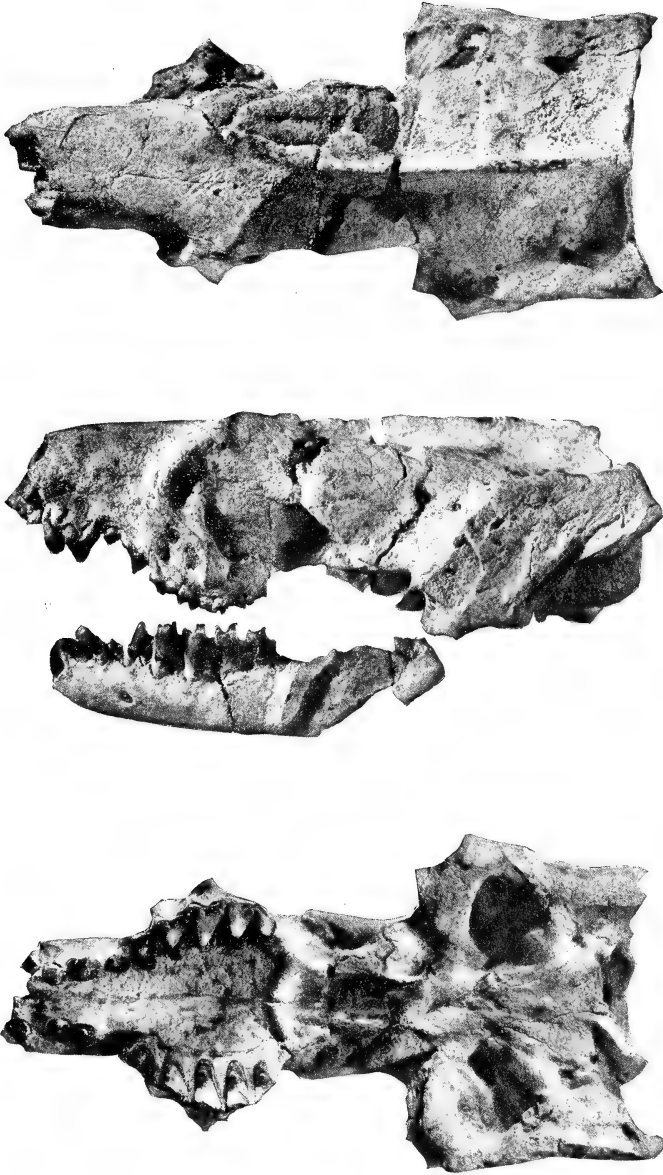
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<sup>1</sup> Sciurid by definition in several respects, but apparently of Castorid affinities.

*Geological Distribution of North American Fossil Rodents.*

	Eocene	Oligocene	Miocene	Plio- cene	Pleis- to- cene
	Puerco Torrejon Wasatch Wind R. L. Bridger U. Bridger U. Washakie U. Uinta Titanoth'm Oreodon Protoceras John Day Harrison Deep R. Nebraska Snake Creek Blanco Equus Megalonyx Modern				
<b>Sciuromorpha</b>					
<b>ISCHYROMYIDÆ</b>					
<i>Paramys</i>	x				
<i>Sciuravus</i>	x				
<i>Mysops</i>	x				
<i>Ischyromys</i>	x				
<i>Prosciurus</i>	x				
? <i>Cylindrodon</i>	x				
<b>APLODONTIIDÆ</b>					
<i>Allomys</i>			x	x	
<i>Mylagaulodon</i>			x		
<i>Aplodontia</i>					x x
<b>MYLAGAULIDÆ</b>					
<i>Mesogaulus</i>				x	
<i>Mylagaulus</i>			x	x	x
<i>Ceratogaulus</i>				x	
<i>Epigaulus</i>				x	
<b>SCIURIDÆ</b>					
<i>Sciurus</i>			x	x	x
<i>Palæarctomys</i>				x	x
<i>Arctomys</i>				x	x
<i>Cynomys</i>				?	x
<i>Tamias, Sperophilus</i> etc.					x x
<b>CASTORIDÆ</b>					
<i>Eutypomys</i>		x			
<i>Stenofiber</i>		x			
<i>Euhapsis</i>			x		
<i>Eucastor</i>			x		
<i>Hystriopsis</i>				?	
<i>Castoroidea</i>				x	x
<b>HETEROMYIDÆ</b>					
<i>Gymnoptychus</i>		x			
<i>Heliscomys</i>		x			
<i>Heteromys</i>			?		
<i>Perognathus, Dipodomys</i> etc.					x x

	Eocene	Oligocene	Miocene	Pliocene	Pleistocene
	Pucteo. Torrejon Wasatch Wind R. L. Bridger U. Bridger U. Washakie U. Uinta	Titanoth'm Orcodon Protoceras John Day	Harrison Deep R. Nebraska	Snake Creek Blanco	Equus Megalonyx
GEOMYIDÆ					
<i>Notoptychus</i> and <i>Pleurolicus</i>			x		
<i>Thomomys</i>			x		
<i>Geomys</i>			x	x	
<b>Myomorpha</b>					
DIPODIDÆ					
? <i>Protoptychus</i>					
? <i>Paciculus</i>	x		x		
MURIDÆ					
<i>Eumys</i>		x	x		
<i>Peromyscus</i>			x		
<i>Neotoma,</i> <i>Reithrodon-</i> <i>toms</i>		x			
<i>Fiber,</i> <i>Microtus</i>					
<b>Hystricomorpha</b>					
ERETHIZONTIDÆ					
<i>Erethizon</i>					
<b>Lagomorpha</b>					
LEPORIDÆ					
<i>Palæolagus</i>		x	x		
<i>Lepus</i>		x	x		
LAGOMYIDÆ (= Ochotonidæ)					
<i>Lagomys</i>					



*Apternodus mediævus*. Skull, enlarged to three diameters; top, side and under views. Lower Oligocene, Wyoming.



**Article VII.**—ON SOME ORTHOPTERA FROM PORTO RICO,  
CULEBRA AND VIEQUES ISLANDS.

BY JAMES A. G. REHN,

Academy of Natural Sciences of Philadelphia.

Several years ago Dr. William M. Wheeler, formerly of the American Museum, placed in my hands for study a small collection of Orthoptera made by him in March, 1906, in Porto Rico, and on Culebra Island. The material was alcoholic and a good portion too immature for positive specific determination. The collection, however, contained a number of species of interest, including a new roach of the genus *Epilampra*, and the results are here presented along with notes on a small lot of Porto Rican and Vieques Island material belonging to the United States National Museum, loaned by the late Dr. Wm. H. Ashmead. My thanks are due the officials of the two institutions for the opportunity to examine these two collections.

BLATTIDÆ.

***Ischnoptera rufescens* (Beauvois).**

Culebra Island, March, 1906. (Wheeler.) [A. M. N. H.] Five males, three females.

Gundlach reported this species from Porto Rico.

***Ceratinoptera diaphana* (Fabricius).**

Culebra Island, March 6, 1906. (Wheeler.) [A. M. N. H.] One male, one female.

***Phœtalia lævigata* (Beauvois).**

Utuado, Porto Rico, March 17, 1906. (Wheeler.) [A. M. N. H.] One female.

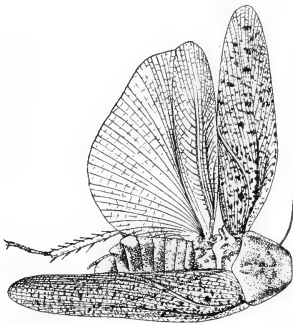
This is apparently the first Porto Rican record of the species, which has also been recorded from Cuba, San Domingo, Martinique and Grenada, as well as from localities in Central and South America and Madeira.

***Epilampra wheeleri* n. sp.**

Type: ♂; Mandios, near Utuado, Porto Rico, alt. 3000 feet, March 17, 1906. (Wm. M. Wheeler.) [Amer. Mus. of Nat. Hist.]

Related to the Cuban *E. carai-bea* and *burmeisteri*, but differing from the former in the caudal coxæ and venter having numerous granulations, in the lateral portions of the pronotum being about as thickly punctulate as mesad and without large punctures and in the longer tegmina and slightly broader pronotum, while from *burmeisteri* it differs in the heavily spotted tegmina and more distinctly spotted legs. Comparison has also been made with *E. insularis* Bolivar from Cuba and *E. sabulosa* and *microspila* Walker from Haiti.

Size medium: from moderately elongate; surface moderately polished. Head completely hidden under the pronotum; interspace between the eyes equal to about half the greatest length of the eye; antennæ incomplete in the type. Pronotum with the narrow cephalic margin rotundato-truncate, the caudal margin moderately produced mesad, the angle of the production well rounded and the sides of this margin very slightly concave, lateral margins converging cephalad, the caudo-lateral angles rotundato-rectangulate, the cephalo-lateral angles rounded; lateral portions of the disk considerably deflected, the dorsal deplanate section rounding into the subvertical lateral section; middle of the disk with two distinct though shallow depressions, one cephalad of the other, the projecting caudal portion of the disk with numerous slight transverse crease-like striæ. Tegmina exceeding the apex of the abdomen by slightly more than the length of the disk of the pronotum, the greatest width of the tegmina being about a third the length of the same; costal margin gently arcuate, the sutural margin rounding distad to the rotundato-angulate apex. Wings with a slight intercalary field. Angles of the abdominal segments obtuse; supra-anal plate produced, bilobate, with a slight median carination proximad; subgenital plate about equal in width to the supra-anal plate but not equalling the same in length, the apical



*Epilampra wheeleri* n. sp. Dorsal view of type. ( $\times 1\frac{1}{2}$ .)

margin broadly rounded, styles slender, short, not reaching caudad of the margin of the supra-anal plate; cerci slightly depressed, fusiform, the apex tapering and exceeding the apical margin of the supra-anal plate by about half the length of the latter. Cephalic femora with the ventro-cephalic margin armed with four large spines mesad and one apical (in addition to the genicular spine) while between these is a series of very short bristle-like spines, ventro-caudal margin with four large spines. Median femora with four spines on the ventro-cephalic and five spines on the ventro-caudal margins; genicular spine robust, apical. Caudal femora with four spines on each margin; genicular spine shorter than on median limbs. Caudal tarsi missing. Cephalic and median tarsi serrato-spinose on each ventral margin, pulvilli prominent.

General color pale ochraceous. Head with a piceous quadrate patch between the eyes, a distinct spot of the same ventrad of each ocellus; occiput punctulate with red brown and piceous, the face sparsely punctulate with piceous; antennæ ochraceous becoming pale red brown distad. Pronotum heavily and uniformly



punctulate with piceous, an indistinct lyrate red brown pattern present on the disk as well as a median red brown spot on each deflected lateral portion of the disk. Tegmina rather heavily punctulate with piceous, the points becoming sparse and more red brown distad, the discoidal and anal field having the base color more suffused with brownish than the costal field which is clear ochraceous-buff with the spots sparser and decidedly red brown; humeral streak decidedly piceous and about a third the entire length of the tegmen; comparatively large punctations of the overlying color are sprinkled rather irregularly over the discoidal and anal fields. Wings infumate, the costal margin dull yellowish and the apex of the wing paler than the remainder, the infumation of the greater portion of the wing being due to the heavy pencilling of the veins. Abdomen dull ochraceous brown dorsad with the lateral portions of the segments and the greater portion of the supra-anal plate pale ochraceous; ventral surface punctulate with deep brownish, the points much thicker distad, the proximal segments with the spots placed on low tubercles; subgenital plate entirely piceous except for the margins which are yellowish aside from the apex which is concolorous with the greater portion of the plate; cerci ochraceous-buff. Median and cephalic coxæ with a number of piceous granulations; femora with several linear series of spots, the dorsal margin of the femora with a weak red brown edging; tibiæ with a piceous spot at the base of each spine, the latter with brownish tips; tarsal joints with their apices piceous.

Measurements.

Length of body . . . . .	17.5 mm.
Length of pronotum . . . . .	6. "
Greatest width of pronotum . . . . .	7.2 "
Length of tegmen . . . . .	21.5 "

The type is the only specimen of the species which has been examined. It is with great pleasure that I dedicate this species to its collector, Dr. William Morton Wheeler.

**Periplaneta australasiæ** (*Fabricius*).

Culebra Island, March 6, 1906. (Wheeler). [A. M. N. H.] One female.

**Periplaneta brunnea** *Burmeister* (*truncata* of Krauss and authors).

Culebra Island, March, 1906. (Wheeler.) [A. M. N. H.] Six males, one adult female, one immature female.

These specimens are very similar to individuals of the species from Sumatra (Batu Sangkar) and Bolivia (Caiza) in the collection of the Academy. Apparently this is the first record of the species from the West Indies.

**Leucophæa maderæ** (*Fabricius*).

Culebra Island, March, 1906. (Wheeler). [A. M. N. H.] Four males, three females, two immature individuals.

**Hemibladera manca** *Saussure*.

Culebra Island, March 5-9, 1906. (Wheeler.) [A. M. N. H.] One male, two females.

The specimens listed above have been compared with a male from Fajardo, Porto Rico. The males of this species have the tegmina subtruncate at the apex, while the females have the same region markedly oblique truncate, the sutural margin hardly more than half as long as the costal one in the last mentioned sex. The reddish median maculation on the pronotum described by Saussure is absent in two of the four specimens examined, very faintly indicated in another and well marked in the fourth. The Culebra male is larger than the Fajardo individual of the same sex.

## ACRIDIDÆ.

**Schistocerca ægyptia** (*Thunberg*).

San Juan, Porto Rico, February 12, 1900. (L. Stejneger.) [U. S. N. M.] One female.

Adjuntas, Porto Rico, 1400 feet elevation, April 13, 1900. (L. Stejneger.) [U. S. N. M.] One female.

These specimens have been compared with individuals of the species from Culebra and Vieques Islands.

## TETTIGONIDÆ.

**Neoconocephalus guttatus** (*Serville*).

El Yunque, Porto Rico, 800 feet elevation, February. (C. W. Richmond.) [U. S. N. M.] One female.

The present author has recorded this species from Bayamon, Porto Rico.

**Neoconocephalus macropterus** (*Redtenbacher*).

San Juan, Porto Rico, February 12, 1900. (L. Stejneger.) [U. S. N. M.] One female.

The comment made under the preceding species also applies to this one.

**Conocephalus fasciatus** (*De Geer*). [*Xiphidium fasciatum* auct.]

Vieques Island, March 27, 1900. (C. W. Richmond.) [U. S. N. M.] One female.

## GRYLLIDÆ.

**Scapteriscus didactylus** (*Latreille*).

Luquillo, Porto Rico, March 5, 1900. (C. W. Richmond.) [U. S. N. M.] One male.

El Yunque, Porto Rico, 800 feet elevation, February, 1900. (C. W. Richmond.) [U. S. N. M.] Two females.

**Anurogryllus muticus** (*De Geer*).

Coamo Springs, Porto Rico, March 23, 1906. (Wheeler.) [A. M. N. H.] One male.

Culebra Island, March 5, 1906. (Wheeler.) [A. M. N. H.] One female.

**Amphiacusta caraibea** (*Saussure*).

Cave near Pueblo Viejo near San Juan, Porto Rico, February 17, 1900. (C. W. Richmond.) [U. S. N. M.] One adult male, one adult female, two immature males, three immature females.

Cueva di Fari near San Juan, Porto Rico, February 14, 1900. (L. Stejneger.) [U. S. N. M.] One immature female.

El Yunque, Porto Rico, 800 feet elev.; February 12, 1900. (C. W. Richmond.) [U. S. N. M.] One adult male.

Vieques Island, March 28. (L. Stejneger.) [U. S. N. M.] One adult male.

Culebra Island, March, 1906. (W. M. Wheeler.) [A. M. N. H.] Two immature males, one immature female.

The immature males are apparently in the stage before the adult condition as the tegmina are present as rounded lobes projecting caudad of the margin of the pronotum a distance about equal to two-thirds the pronotal length, the surface having the venation of the adult male faintly outlined.

As no measurements have been published of the adult female the following taken from the only adult female in the series will add to our knowledge of the species.

Length of body . . . . .	16. mm.
Length of pronotum . . . . .	4. "
Greatest width of pronotum . . . . .	5.5 "
Length of caudal femur . . . . .	19.5 "
Length of caudal tibia . . . . .	21 "
Length of ovipositor . . . . .	20 "

The species is now known from several of the Lesser Antilles, Vieques and Culebra Islands and Porto Rico.



**Article VIII.**—SOME PARASITIC HYMENOPTERA FROM  
VERA CRUZ, MEXICO.

BY CHARLES T. BRUES.<sup>1</sup>

The following notes and descriptions are based on a small, but extremely interesting collection of Parasitic Hymenoptera made in the state of Vera Cruz, Mexico, by Dr. Alexander Petrunkevitch, and now contained in the American Museum of Natural History. As would be expected from the very meager knowledge which we have of the small Hymenoptera of this region, the majority of the specimens in the present collection represent hitherto undescribed species.

Family PLATYGASTERIDÆ.

**Metanopedias** gen. nov.

Antennæ of female 9-jointed, with loose, slender, 4-jointed club; second flagellar joint long, and very closely united with the first. Eyes bare, ocelli in a broad triangle, the lateral ones distinctly nearer to the eye than to the median ocellus. Thorax long, pronotum visible in front and on the sides of the mesonotum. Mesonotum long and narrow, with deep, parallel parapsidal furrows; its median lobe projecting over the scutellum from which it is not separated by any suture. Scutellum rounded at the tip, compressed from the sides, so that anteriorly its surface is much below the parapsides leaving these declivous behind and angularly produced laterally. Metathorax very short. Abdomen with four visible segments, one-half longer than the head and thorax together, subpetiolate; first segment about as long as broad, with four longitudinal carinæ above, giving it a very coarsely fluted appearance; second segment very long; third narrower, short; fourth long and narrow, produced as a flattened spatulate ovipositor nearly as long as the rest of the abdomen. Legs as usual; wings veinless.

**Metanopedias sicarius** sp. nov.

*Female.* Length 2 mm. Black, the scape of the antennæ and the legs, except coxæ and clavate part of hind femora, reddish yellow. Head broad, twice as wide as thick, and fully one-third wider than the thorax. Front smooth and polished, except for a shagreened sculpture near the insertion of the antennæ, along the inner margins of the eyes and within the ocellar triangle. Head behind circularly striated, the occipital foramen small, margined. Mesonotum smooth and highly polished,

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<sup>1</sup> Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University. No. 16.

the parapsidal furrows parallel and complete. Scutellum microscopically rugulose, thinly pubescent apically. Pleuræ smooth and highly polished, except the meta-

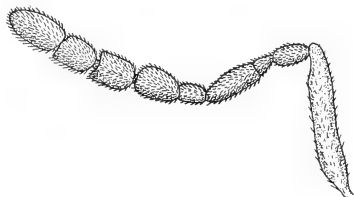


Fig. 1. Antenna of *Metanopiedius sicarius* sp. nov., ♀.

pleuræ, which are thinly yellowish pubescent. Mesopleura above with a narrow longitudinal furrow, below with a broader, less sharply defined one which extends on to the metapleura. Abdomen flattened, especially on its apical half; second and third smooth and polished, the disk of the third with a curved discal transverse row of coarse punctures. Fourth segment densely longitudinally aciculate on its basal third, apically smooth, its sides

slightly convergent until near the tip which is bluntly pointed.

Vera Cruz, collected by Dr. A. Petrunkevitch at Buena Ventura, near Santa Rosa, July 13, on herbage.

This peculiar species undoubtedly represents an undescribed genus in this family, which is so richly represented in the American tropics.

#### Family SCELIONIDÆ.

##### *Idris quadrispinosus* sp. nov.

*Male.* Length  $1\frac{1}{2}$  mm. Ferruginous, head, except near the mouth, and antennæ, except scape, black; abdomen dark at tip, and yellow medially on the third segment; legs brownish-yellow. Head large and broad, twice as wide as thick, sharply margined behind on the sides, but not above. Viewed from above, the eyes occupy one-half of the side of the head. Ocelli in a triangle, the lateral ones nearer to the eye-margin than to the median one. Eyes pubescent. Front above the insertion of the antennæ smooth and polished halfway to the ocellus; with a slight median depression; above thinly whitish hairy, and coarsely, densely punctate to the occiput. Head behind the eyes less closely punctate. Mandibles tridentate; cheeks smooth, with a distinct malar furrow just in front of which is a delicate fan-shaped series of striæ diverging from the base of the mandible. Antennæ 12-jointed, slender, with cylindrical joints; scape as long as the three following joints; pedicel narrowed at the base, as long as the second flagellar joint; first flagellar joint thicker, and one-fourth longer than the second; second and following about equal, each twice as long as thick; last one-third longer. Mesonotum entire, closely and coarsely punctate, without any traces of parapsidal furrows. Scutellum simple, twice as broad as long, sculptured like the mesonotum; postscutellum simple. Metathorax with a pair of lateral carinæ that diverge behind; each one produced as a sharp tooth at each extremity, giving the metathorax a quadrispinose appearance. Viewed from the front the upper pair of teeth are seen to be conspicuously white pubescent. Pleuræ with scattered coarse punctures, the mesopleura with a deep smooth femoral furrow below; metapleura with a sharp carina along its anterior margin. Abdomen shining, subpetiolate, sparsely beset with white hairs; petiole twice as long as wide, finely longitudinally fluted; second segment one-half longer, striate basally, the striæ short on the sides, but nearly reaching the tip near the

middle; third segment the widest, nearly as long as the second, and one-half wider than long, smooth and shining, fourth, fifth and sixth growing shorter, together a little longer than the third; very finely punctulate, following scarcely projecting. Wings hyaline, neuration pale brown, basal vein distinctly indicated by a fuscous streak; marginal vein short and not unusually thick, about twice as long as wide; postmarginal very short only two-thirds the length of the marginal; stigmal vein long, with a small, but distinct knob at the tip. Legs slender, brownish yellow.

Type collected by Dr. A. Petrunkevitch at Buena Ventura, near Santa Rosa, Vera Cruz, July 13. "Swept with net from grass and bushes."

I was in doubt as to the correct generic position for this insect which is evidently congeneric with the North American *I. nigricornis* Brues, and am indebted to Mr. J. C. Crawford of the U. S. National Museum for comparing it with Ashmead's type of *I. læviceps*. From the latter it differs in having no parapsidal furrows and no spine-like projections on the metanotal carinæ. I think, however, there can be no doubt that all three are congeneric. Quite recently Kieffer (Ann. Soc. Sci. Bruxelles, Vol. XXXII, p. 123, 1908) has overturned Ashmead's conception of the genus *Idris* and described Förster's manuscript type which had never been described. He therefore referred the occidental species to a new genus, *Paridris*. However on a previous page of the same paper (p. 119) he refers these same forms to *Anteris* Först. In view of such confusion I think our species must remain in *Idris* which was first accurately described by Ashmead in 1893.

### **Opisthacantha** Ashm.

#### *Key to the species.*

1. Mesonotum with furrows; post-scutellar spine very minute . . . . . *O. polita* Ashm.  
    Mesonotum with distinct furrows, at least on its posterior half . . . . . 2
2. Second abdominal segment smooth or nearly so, body brownish yellow.  
    . . . . . *O. pallida* Ashm.  
    First three abdominal segments striated . . . . . 3
3. Marginal vein about as long as the stigmal; parapsidal furrows complete  
    . . . . . *O. mellipes* Ashm.  
    Marginal vein two-thirds as long as the stigmal; parapsidal furrows present only  
    on posterior half of mesonotum . . . . . *O. striativentris* sp. nov.

### **Opisthacantha striativentris** sp. nov.

*Female.* Length 1.5 mm. Black; legs, including coxæ, and scape of antennæ yellow. Head slightly wider than the thorax, twice as wide as thick. Front finely shagreened, with delicate punctures intermixed; above the antennæ with a large circular smooth, polished space bearing a sharp median carina which extends halfway to the median ocellus. Eyes thickly pubescent. Ocelli in a large triangle, the lateral ones almost touching the eye-margin. Cheeks with fan-shaped striations extending

from the insertion of the antennæ. Antennæ 12-jointed, with a 6-jointed club; pedicel long, nearly as long as the two following joints together; first, second and third flagellar joints decreasing in length, the third quadrate, fourth very small, moniliform; first and second club joints short, widening, the second three times as wide as long; third to fifth about equal, large, each twice as broad as long; last conic, twice as long as the penultimate. Head margined behind, punctato-strigose, behind the eyes. Occiput faintly shagreened. Thorax above minutely punctulate or shagreened. Mesonotum with the parapsidal furrows very distinct posteriorly, but not indicated on the anterior half. Scutellum broad, rounded behind; about twice as broad as long; near the apex with a foveate line. Postscutellum very short, semi-circular, with a prominent median tooth at the apex and a foveate line across the base. Metathorax very short, deeply emarginate posteriorly, with the lateral apical angles produced as teeth. Abdomen one-third longer than the head and thorax together; oval in outline, its base being one-half as broad as its widest part; first segment twice as broad as long, deeply striated longitudinally for its entire length. Second segment nearly twice as long as the first, more finely striated; the striæ obsolete behind on each side. Third segment the longest and widest, one-half longer than the second; still more finely striated than the second, except on its apical and lateral fourths which are smooth; following segments (4-6) nearly equal in length and together as long as the third although rapidly narrowing, finely shagreened. Venter shagreened. Legs, including all coxæ, yellow. Wings hyaline, with a faint brownish tinge. One basal cell very faintly indicated; marginal vein short, three times as long as thick, about two-thirds as long as the knobbed stigmal; post-marginal fully twice as long as the stigmal.

*Male.* Differs from the female by its paler, more testaceous legs, and by brownish color on the metathorax and abdomen basally. The antennæ are filiform with the flagellar joints of about equal length except that the first is quite distinctly longer and thicker; pedicel subtriangular, two-thirds as long as the first flagellar joint. Abdomen with seven visible segments.

Described from two specimens from Vera Cruz collected by Dr. Alexander Petrunkevitch.

### *Scelio guatemalensis* Kieffer.

Berliner. entom. Zeitschr. 50, p. 270 (1905).

A specimen from Buena Ventura is referable to this species, originally described from Guatemala. It differs from the type in having the abdomen tinged with reddish brown medially both above and below.

### *Scelio erythropoda* Cameron.

Biol. Centr.-Amer., Hym. Paras. p. 436 (1888).

There are four specimens of *Scelio* from Buena Ventura which agree with Cameron's species in size and other characters given in his brief description, although they will not run to this species in Kieffer's recent table (Ann. Soc. Sci. Bruxelles, 32, part 2, p. 132), and may possibly represent an undescribed species.



## Family ENCYRTIDÆ.

**Anusioptera** gen. nov.

*Male.* Body rather slender, with long legs and antennæ; wings fully developed. Head of moderate size, rostriform, much produced below the eyes into a short beak. Mandibles small, bidentate. Maxillary palpi short, four-jointed; labials also short, three-jointed. Malar furrow obsolete, faintly indicated above. Eyes bare, twice as high as wide, emarginated on their posterior border. Antennæ inserted in small depressions near the base of the mandibles, with very short grooves above for the reception of the first joint. Front long and narrow, gradually widening below, its surface punctulate. Ocelli in a triangle, the lateral ones near the eye-margin and closer to one another than to the median ocellus. Antennæ long; basal joint (presumably homologous to the short joint which articulates the scape to the head) as long as the width of the eye, slender; scape as long as the head height, very slender, cylindrical. Pedicel small; no ring joints; flagellum strongly flattened, seven-jointed, nearly as broad as the eye. Prothorax visible from above, mesonotum large, nearly as long as broad; axillæ nearly meeting medially, scutellum convex, smooth. Metathorax smooth and shining above, finely sculptured on the sides; the pleural piece large, twice as long as high. Abdomen short, compressed, with three long, bristly hairs on each side near the middle. Legs very long and slender. Metatarsus of middle legs slender, with scarcely evident denticles. Wings hyaline, with a dark transverse cloud and dusky apex. Marginal vein long, stigmal and post-marginal short, about equal, the former nearly perpendicular.

This peculiar insect shows a considerable similarity to *Anusia* Forster, known from the Palæarctic and Nearctic regions, but differs greatly in several respects. The elongation of the basal articulation of the antennal scape is quite extraordinary, and the scape is simple, not dilated as in *Anusia* although the flagellum has the greatly flattened form seen in this genus. The rostriform mouthparts are also peculiar, and the metathorax is much longer than in *Anusia*. Type *A. aureocincta* sp. nov.

**Anusioptera aureocincta** sp. nov.

*Male.* Length 4 mm. Clear honey-yellow, except the antennal flagellum, metapleuræ, small dorsal spot near center of abdomen, and double (one internal and one external) stripes on the femora and tibiæ, which are black. Tarsi, except basal joint of middle pair, also black. Head seen from in front slightly longer than wide across the eyes. Mandibles tipped with black; apical joint of both pairs of palpi black; projecting mouth parts yellowish white. Basal joint of antennæ not quite half as long as the scape, which is somewhat blackened above. Pedicel short; one-fifth the length of the first joint of the flagellum, fuscous. From the base, the flagellum gradually widens on the first three joints which decrease in length, the third being three-fifths the length of the first and twice as wide at the tip; fourth joint subequal to the third, about quadrate; following shortening and rapidly narrowing to the tip. Pro- and mesothorax smooth, sparsely covered with microscopic

hairs. Metanotum with two very delicate black, divergent carinæ near the middle; metapleuræ finely rugulose, spiracle large, circular. Abdomen with the basal and apical segments elongated, the median ones short and not distinctly delimited. Middle femora reaching well beyond the tip of the abdomen. Wings hyaline on their basal two-fifths, then with a cross band of shining golden pubescence which extends beyond the middle and is fuscous by transmitted light; then with a narrow black band, followed by a hyaline band before the infuscated tip. Hind wings hyaline.

Collected by Dr. Petrunkevitch at Buena Ventura, near Santa Rosa, Vera Cruz, July 13; swept from grass and bushes.

This is a most striking and bizarre form.

***Ænasia* Walker.**

*Key to the species.*

1. Mesonotum with coarse punctures, like those of the head . . . *A. chapadæ* Ashm.  
Mesonotum smooth or shagreened . . . . . 2.
2. Marginal vein short, almost wanting; head black . . . *A. hyettus* Walk.  
Marginal vein nearly as long as the stigmal; head metallic blue.  
*A. cæruleus* sp. nov.

***Ænasia cæruleus* sp. nov.**

*Female.* Length 3 mm. Head, mesonotum and scutellum bright metallic blue; abdomen bluish, with a purple cast. Head broadly transverse, fully three times as wide as thick; viewed from above, the narrowest part of the front occupies less than one-fifth of the width of the head. Ocelli in a large, equilateral triangle, the lateral ones touching the eye margin. Eyes thickly covered with dark pubescence. Occipital margin sharp. Front closely covered with large, thimble-shaped setigerous punctures each bearing a single glistening white seta. Facial depression nearly smooth; the antennal grooves converging above, finely transversely aciculate. Mandibles small, acute, with three teeth; piceous. Palpi black. Antennæ black; scape nearly two-thirds as long as the flagellum, with a broad thin cleaver-shaped expansion below which is as wide as the narrowest part of the front between the eyes. Basal joints of the flagellum very short, rapidly widening and strongly transverse to the first club-joint which is as broad as the dilated scape and about three times as wide as long; from thence the club is very obliquely truncate, the truncate surface flat, so that it appears triangular when seen perpendicularly and when seen from the side the tip of the antenna appears conical. Pronotum narrow, but visible from above as a transverse band of even width. Mesonotum over twice as broad as long, medially fully one-half longer than laterally at the anterior angles of the axillæ; its surface shagreened, with sparse delicate punctures, each bearing a fine black seta; its narrow posterior border entirely smooth. Scutellum about one-fourth longer than the mesonotum; the axillæ separated by only a very delicate suture, well apart at their inner angles; forming together with the scutellum a regularly shield-shaped piece, as long as wide at the base and sculptured like the mesonotum. Median longitudinal furrow of scutellum reaching to the basal fourth. Abdomen short and conically pointed, extending for the length of the scutellum from the tip of the latter.

Second segment quite long, one-third as long as the remaining ones taken together; third with a spiracle bearing two long black bristly hairs; following segments sharply triangularly narrowed, with a very distinct lateral rim. Entire abdomen shining, smooth, or nearly so, with a purplish cast. Legs slender, black; tibiae with indistinct longitudinal brownish stripes; denticles on middle metatarsus minute, but very distinct. Anterior wings strongly infuscated, paler at the apex and posteriorly on the apical one-half. Submarginal vein reaching to the middle of the wing; marginal and postmarginal veins of equal length, together more than one-third as long as the submarginal; stigmal slightly longer than the postmarginal with a small knob at the tip. Posterior wings hyaline; marginal cell terminated at the apical third of the wing.

Described from a specimen collected by Dr. Alexander Petrunkevitch at La Buena Ventura, near Santa Rosa, Vera Cruz, July 13, in sweepings from grass and bushes.



**Article IX.**— ADDITIONAL MAMMALS FROM NICARAGUA.

BY J. A. ALLEN.

The present paper is a further report on the mammals collected by Mr. William B. Richardson in Nicaragua for this Museum, his work there now having been brought to a close, at least for the present. In my former paper <sup>1</sup> 50 species were recorded,<sup>2</sup> based on the 400 specimens received from Mr. Richardson up to that date. About the same number of specimens has since been received, increasing the number of species to 82, 28 being now added. In order to give in the present paper a full list of the species of mammals collected by Mr. Richardson in Nicaragua, those of the first paper are here listed, whether or not they are represented in the later collections, with a cross-reference to the earlier paper and mention of the localities from which they were previously received.

Mr. Richardson's collection naturally lacks many species that undoubtedly occur in Nicaragua. Although he covered a wide range of country, many parts of the Republic were not visited, his explorations being confined mainly to the central and northern part. A little collecting was done on the west coast, at Chinandega (altitude 700 feet), in May, 1907, and at Volcan de Chinandega (altitude 5000 feet) in August, 1908, and along the inner border of the low east coast region at Savala <sup>3</sup> and Rio Grande, at altitudes respectively of 800 and 700 feet, and at Tuma and Chontales, at 1000 feet. The greater part of the specimens were obtained, however, in the highlands, from Matagalpa (2000 feet) north to the border of Honduras at altitudes of 4000 feet (Ocotol) to 5000 feet (San Rafael del Norte). Thus the lowlands, including the borders of Lakes Managua and Nicaragua and the southern and coast regions below 500 feet, were not visited. The following revised list of the principal localities and their altitudes is based on a sketch map received from Mr. Richardson since the publication of the former paper on his collection.

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<sup>1</sup> See 'Mammals from Nicaragua,' this Bulletin, Vol. XXIV, 1908, pp. 647-670, Oct. 13, 1908.

<sup>2</sup> Reduced in the present paper to 54, through the elimination of three unidentified supposed species of *Reithrodontomys* (*l. c.* p. 654), and the reduction of two subspecies to synonyms (see below pp. 100 and 114).

<sup>3</sup> Incorrectly given in my former paper as Lavala.

1. *Highlands of Northern Nicaragua.*

Jalapa, Honduras border, 3000 feet.

Ocotal and Yali, near Honduras border, 4000 feet.

Quilali, 1800 feet.

San Juan Telpaneca, 3500 feet.

San Rafael del Norte, 5000 feet.

Matagalpa, 2000 feet.

All of these localities are north of Matagalpa.

2. *West Coast, near Corinto.*

Chinandega, 700 feet.

Volcan de Chinandega (or Volcan El Viejo), 5000 feet, with pine forest above 3000 feet.

3. *East Slope of the Highlands.*

Rio Coco, 800 feet

Tuma, 1000 feet.

Uluce, about 1000 feet.

Savala, 800 feet.

Rio Tuma (at a rubber hunter's camp), 500 feet.

Rio Grande, 700 feet.

Chontales, 1000 to 1500 feet.

Pena Blanca, a high point in the low Atlantic coast forests, having an elevation of 1500 feet.

Muy Muy and Vijagua are on the eastern slope of the highland in Malagalpa Province; altitude probably 1500 to 2000 feet.

The immediate coast regions, both east and west, were practically unvisited and still offer an inviting field for future exploration, only sporadic work, mainly in the vicinity of Bluefields, having as yet been undertaken.

As would be expected, the mammalian fauna of Nicaragua consists of two principal elements, a northern, in the highlands of the central and northern districts, and a southern or tropical in the lowlands. There are no peculiar genera, but many distinctively tropical genera range north not only to Nicaragua but to Honduras, Guatemala, and the lowlands of southern Mexico. These include, among others, three genera of monkeys (*Ateles*, *Alouatta*, and *Cebus*), the sloths (both *Choloepus* and *Bradypus*), three genera of anteaters (*Myrmecophaga*, at least to Honduras, *Tamandua*, and *Cyclopes*), the smaller opossums (*Marmosa*, *Metachirus*, *Chironectes*, and *Caluromys*, the last two only to Nicaragua), various genera and subgenera of rodents, of which the following do not appear to extend much beyond Nicaragua, except in the low east coast region, namely: *Agouti*, *Proechimys*, *Hoplomys*, *Macrogeomys*, *Nectomys*, *Melanomys*, *Akodon*, *Guerlinguetus*,

and *Microsciurus*; other tropical rodent genera, like *Coendou*, *Dasyprocta*, and *Tapeti*, reach the hot lowlands of southern Mexico. Among carnivores the genera *Nasua*, *Bassariscus*, *Potos*, *Tayra*, and *Grisson*, reach southern Mexico, while *Bassaricyon* is not known beyond Nicaragua. *Tapirella*, *Trichechus*, and *Mazama* have been recorded north to Mexico. A very large number of tropical genera of bats range from South America to southern Mexico.

On the other hand, several northern genera extend southward from the highlands of Mexico and Guatemala to the higher portions of northern and central Nicaragua, as *Baiomys*, *Neotoma*, *Urocyon*, *Mephitis*, *Spilogale*, *Sorex*, *Blarina*, *Nycteris* (= *Lasiurus*), *Eptesicus*, etc., exclusive of such genera as are common to both North America and South America.

As already intimated, the collections made by Mr. Richardson, while so large and important, represent probably less than two-thirds of the species of mammals that actually occur in Nicaragua, since, as noted above, he did very little work below the 700 feet contour line, and did not explore any part of the east coast region below 500 feet elevation, in which area doubtless many species not obtained by him extend northward from the lowlands of Panama and Costa Rica, and where doubtless undescribed forms remain to be discovered. Furthermore, he obtained only a relatively small number of species of bats. Previous work in Nicaragua had been extremely limited and desultory, yet 13 species had been based, prior to Mr. Richardson's work, on specimens obtained in Nicaragua. But the literature dealing directly with the mammals of this Republic is exceedingly scanty.

Alston's 'Mammalia' (1879-1882) of the 'Biologia Centrali-Americana,' contains 177 species (excluding 4 introduced species of *Mus*), of which only 18 are definitely recorded<sup>1</sup> from Nicaragua; these are given in part on the basis of previously published records and in part on specimens in the British, Paris, and Berlin museums. From this number two should be subtracted as resting on records which prove to have been erroneous, leaving 16 species as the number explicitly recorded from Nicaragua. Various species had since been added, raising the number authentically established prior to 1908 as Nicaraguan to 34. It seems desirable to present in this connection a tentative list of the mammals of Nicaragua, based on actual records, so far as they go, and in part on the known range of the species here included.

As said above, the literature relating to Nicaragua mammals is extremely scanty. Indeed, I have been able to find only a single paper on mammals which contains in its title a reference to Nicaragua. This is by Mr. Oldfield

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<sup>1</sup> That is, in the text, but three others, making 21, are given as occurring in Nicaragua in the table of 'General Distribution of Central American Mammals' (pp. iv-ix).

Thomas,<sup>1</sup> and records 4 species, one of them being not only new but the type of a new genus. Dr. F. W. True<sup>2</sup> has made brief mention of a small collection made by Dr. L. F. H. Birt in the vicinity of Greytown. It consists of a nominal list of 7 species, with special mention of another (*Echinomys semispinosus* Tomes = *Hoplomys truei* Allen), the seven species being *Mycetes palliatus*, *Dicotyles labiatus*, *Sciurus hypopyrrhus*, *Bradypus castaneiceps*, *Cycloturus didactylus*, *Tatusia novemcincta*, and *Didelphis opossum*. Later Mr. G. H. Miller, Jr., described a small bat (*Micronycteris microtis*) from apparently the same collection.

Dr. True has also given an account<sup>3</sup> of a small collection of mammals made by Mr. Charles W. Townsend on the Segovia River, the boundary between Honduras and Nicaragua.<sup>4</sup> Besides describing a new form of *Capromys* (*C. brachyurus thoracicus*) from Little Swan Island, in the Bay of Honduras, he gives an annotated list of 13 species of mammals collected along the Segovia River "and the vicinity of Truxillo." This collection furnished the original material on which was based True's *Cariacus clavatus* (= *Odocoileus truei* Merriam), and the type of *Ectophylla alba* H. Allen, described sometime later.

In 1892, Dr. Charles W. Richmond made a considerable collection of mammals at Greytown and on the Escondido River, 50 miles above Bluefields, which has furnished the types of a number of new species,<sup>5</sup> but no general account of the collection appears to have been published.

Doubtless much mammal material from Nicaragua exists in other museums, in this country and in Europe, to which only casual and incomplete reference has hitherto been published, and is thus unavailable as a source of information in the present attempt to compile a list of the species of Nicaragua mammals; doubtless some of the published incidental references to such material have been overlooked in the present connection, yet the tentative list here presented may serve a useful purpose as the nucleus for future additions and corrections.

<sup>1</sup> On small Mammals from Nicaragua and Bogota. By Oldfield Thomas. Ann. and Mag. Nat. Hist. (6), XVI, July, 1895, pp. 56-60. *Lichonycteris obscurus* gen. et sp. nov., p. 56.

<sup>2</sup> On the Occurrence of *Echinomys semi-spinosus* Tomes in Nicaragua. By Frederick W. True. Proc. U. S. Nat. Mus., XI, 1888 (1889), pp. 467, 468.

<sup>3</sup> On Mammals collected in Eastern Honduras in 1887 by Mr. Charles W. Townsend, with a description of a new subspecies of *Capromys* from Little Swan Island [Bay of Honduras]. By Frederick W. True. Proc. U. S. Nat. Mus., XI, 1888 (1889), pp. 469-472.

<sup>4</sup> In reply to my inquiries regarding the localities at which he collected Mr. Townsend has kindly given the following information. He says, in a letter dated April 11, 1910: "I started in from Cabo Gracias á Dios. Most of my camps were in the open pine woods above Soohée, where there is but little elevation. I did not reach the hill country and was seldom more than a few miles from the river. All collecting done at Truxillo on the Nicaragua coast, was within a few miles of the town. . . . The whole region along the river is a jungle with open pine forests adjacent."

<sup>5</sup> *Didelphis richmondi* Allen, *Sciurus richmondi* Nelson, *Sciurus boothiæ belti* Nelson, and *Oryzomys richmondi* Merriam.



Notwithstanding the comparatively infrequent mention of Nicaragua mammals in literature, 34 species and subspecies have been based on Nicaragua specimens, including the 4 described in the present paper. Of these 17, or just one half, have been based on the Richardson collections. Four of these 34 forms are shown in the following pages to hold at present only the rank of synonyms. The names of the four forms described below are printed in heavy-faced type in the following list.

*List of Species and Subspecies based on Nicaragua Specimens.*

- Marmosa cinerea nicaraguæ* Thomas (1905), Bluefields.  
 [Metachirus fuscogriseus Allen (1900). Type locality unknown but presumed to be Colon, yet quite as likely to have been either Bluefields or Greytown.]  
*Didelphis richmondi* Allen (1901), Greytown.  
*Arctopithecus castaneiceps* Gray = *Bradypus griseus* (Gray), 1871, Chontales.  
*Cariacus clavatus* True, 1889 [preoccupied = *Odocoileus truei* Merriam, 1898], Segovia River (northeastern boundary of Nicaragua).  
*Sylvilagus gabbi tumacus* (Allen, 1908), Tuma.  
*Hoplomys truei* Allen (1908), Savala.  
*Heteromys fuscatus* Allen (1908), Tuma.  
*Heteromys vulcani* Allen (1908), Volcan de Chinandega.  
**Macrogeomys matagalpæ** Allen (infra, p. 97, 1910), Matagalpa.  
*Neotoma chrysomelas* Allen (1908), Matagalpa.  
*Reithrodontomys modestus* Thomas (1907), Jinotega.  
*Oryzomys alfaroi incertus* Allen (1908 = *O. alfaroi*, cf. infra, p. 100), Rio Grande.  
*Oryzomys ochraceus* Allen (1908), Rio Grande.  
**Oryzomys richardsoni** Allen (1910, infra, p. 99), Rio Grande.  
**Oryzomys nicaraguæ** Allen (1910, infra, p. 100), Vijagua.  
*Sigmodon hispidus griseus* Allen (1908), Chontales.  
*Ototylomys fumeus* Allen (1908), Matagalpa.  
*Nectomys dimidiatus* Thomas (1905), near Rama.  
*Peromyscus nicaraguæ* Allen (1908 = *P. mexicanus saxatilis* Merriam, cf. infra, p. 100), Matagalpa.  
*Sciurus boothiæ belti* Nelson (1899), Escondido River.  
*Macroxus adolphei*, Lesson (1842 = *Sciurus variegatoides adolphei*, infra, p. 103), Realejo.  
*Sciurus richmondi* Nelson (1898), Escondido River.  
*Sciurus deppei matagalpæ* Allen (1908), San Rafael del Norte.  
*Lutra latidens* Allen (1908), Savala.  
*Tayra barbara inserta* Allen (1908), Ulucé.  
**Conepatus nicaraguæ** Allen (1910, infra, p. 106), San Rafael del Norte.  
*Bassaricyon richardsoni* Allen (1908), Rio Grande.  
*Blarina olivacea* Allen (1908), San Rafael del Norte.  
*Micronycteris microtis* Miller (1898), Greytown.  
*Lichonycteris obscurus* Thomas (1895), Managua.  
*Ectophylla alba* H. Allen (1898), Segovia River.  
*Artibeus jamaicensis richardsoni* Allen (1908), Matagalpa.

*Mycetes palliata* Gray (1842), banks and islands of Lake Micaragua.

*Alouatta palliata matagalpæ* Allen (1908), Savala (= *Mycetes palliata* Gray, cf. infra, p. 114).

#### LIST OF NICARAGUA MAMMALS.

In the following list the names of the species and subspecies represented in the Richardson collections are printed in heavy-face type and are consecutively numbered.<sup>1</sup> The names of those not represented in the Richardson collections (50 species) are in italic type. One star prefixed to a name indicates that the species has been recorded from Nicaragua; two stars thus prefixed indicates that the species was originally based on Nicaragua specimens. The absence of such marks indicates that the species is included on the basis of its general range, as now understood: in some instances, on records from Costa Rica and either Honduras or Guatemala; in others on the general fact that it is a more or less common tropical species with a recognized range extending from Brazil to southern Mexico. This gives a list 122 species as of known or of practically certain occurrence. Twelve other species are referred to [in brackets] as of probable or possible occurrence.

The species obtained by Richardson number 82, of which only 13 are bats; of the 50 additional species here recognized provisionally as Nicaraguan, 38 are bats, showing that the chief deficiencies in the Richardson collection are in the Chiroptera, of which apparently not less than 50 species should occur in Nicaragua.

I am indebted to Dr. C. Hart Merriam, Chief of Biological Survey, for the loan of specimens for use in the present connection, and to Mr. E. W. Nelson and Mr. Gerrit S. Miller, Jr., for aid in determining some of the squirrels and bats.

1. **Marmosa murina** (*Linnaeus*). (Bull., XXIV, 1908, p. 648: San Rafael del Norte.)

Six specimens, mostly immature: Ocotal, May 9; Matagalpa, Oct. 11; Rio Coco, Nov. 11 and Dec. 1, 1908; Vijagua, March 21 and 30, 1909.

2. **Marmosa murina mexicana** *Merriam*. (Bull., XXIV, 1908, p. 648: Volcan de Chinandega.)

\* \* *Marmosa cinerea nicaraguæ* Thomas. (Ann. and Mag. Nat. Hist., (7), XVI, Sept. 1905, p. 313). Type locality, "Bluefields, Nicaragua: sea-level."

3. **Caluromys laniger pallidus** *Thomas*. (Bull., XXIV, 1908, p. 648: Matagalpa.)

<sup>1</sup> Those additional to the species given in the first paper are indicated by an obeliok (†) prefixed to the current number.

4. ***Metachirus fuscogriseus* Allen.** (Bull., XXIV, 1908, p. 648: Matagalpa, San Rafael del Norte, Savala, and Tuma.)

Fourteen specimens: Volcan de Chinandega (1), Aug. 22; Rio Coco (8), Nov. 15, 18, 19, 25, Dec. 1-3, 1908; San Juan (2), Jan. 3, 5; San Rafael del Norte (1), Feb. 3; Vijagua (1), March 19; Pena Blanca (1), June 6, 1909.

Three specimens in worn pelage are much paler than the others, in which the back is strongly varied with blackish, and the whole upper surface of the head, except the white supraocular patches, is blackish brown, the coronal region black.

5. ***Metachirus nudicaudatus colombianus* Allen.** (Bull., XXIV, 1908, p. 648: Chontales.)

6. ***Didelphis mesamericana tabascensis* Allen.** (Bull., XXIV, p. 648: Matagalpa and Savala.)

Twelve specimens, mostly immature: Matagalpa (6), June 5, Oct. 10, 11, 28, Dec. 10; Rio Coco (3), Nov. 9-14, 1908; Jalapa (1), Jan. 23; Pena Blanca (2), June 6, 1909. Only three are in the black phase.

\* \* *Didelphis richmondi* Allen. Greytown, Nicaragua. Not represented in the present collection.

*Chironectes minima* (Zimmermann). Recorded from both Guatemala and Costa Rica on apparently good authority, and hence may be supposed to occur in Nicaragua.

7. ***Cholœpus hoffmanni* Peters.** (Bull., XXIV, 1908, p. 648: Matagalpa.)

Three specimens: Matagalpa (2), Dec. 21, 1908; Uluce (1), July 30, 1909. One of the Matagalpa specimens is a young one in the first pelage (total length, 220 mm.); it is dark wood brown above, somewhat lighter below, the pelage fine and soft.

8. ***Bradypus griseus* (Gray).** (Bull. XXIV, 1908, p. 648: Chontales.)

*Arctopithecus griseus* GRAY, Ann. and Mag. Nat. Hist. (4), VII, April, 1871, 302; P. Z. S., 1871, 446, pl. xxxvi (animal), text fig. 6 (young skull). Costa Rica.

*Arctopithecus castaneiceps* GRAY, P. Z. S., 1871, 444, pl. xxxv (animal), text fig. 5 (adult skull). Chontales, Nicaragua.

*Bradypus griseus* ALLEN, Bull. Am. Mus. Nat. Hist., XXIV, 648 (Chontales).

Represented by three specimens, two adult females and a young specimen in first pelage. Two of them are from the type locality of *Arctopithecus castaneiceps* Gray, but they lack the chestnut color on the forehead and sides of the neck shown in Gray's colored plate of this species, thus closely resembling in this respect his plate of *A. griseus*, and also in the dorsal patch of the male being blotched externally with black. The other specimen is from Rio Coco, collected Nov. 19, 1908. Both are sexed as females, but one

of them, said to be the mother of the young one, has the black dorsal stripe (bordered with dull orange), while the other shows no trace of such markings.

As Costa Rica and Nicaragua specimens do not seem to differ essentially, the name *griseus* is adopted as having slight priority.

9. *Cyclopes dorsalis* (Gray). (Bull., XXIV, 1908, p. 648: Rio Grande.)

10. *Tamandua tetradactyla chiriquensis* Allen. (Bull., XXIV, 1908, p. 648: Ocotol).

Three specimens, an adult female and a young one about a week old, Muy Muy, July 28, 1908; half-grown male, Vijagua, March 25, 1909.

*Myrmecophaga tridactyla centralis* Lyon. Mentioned by Richardson in letters as occurring in the forest lowlands of the east coast. Recorded by Salvin as taken "near Punta Gorda, on the coast of the Bay of Honduras."

11. *Tatu novemcinctus* (Linnæus). (Bull., XXIV, 1908, p. 649: Savala.)

Two adult females: Rio Coco, Nov. 8, 1908; Pena Blanca, June 7, 1909.

*Cabassous centralis* (Miller). The type of this species came from Honduras, to which a specimen from Costa Rica is referred by the describer,<sup>1</sup> who says: "The Costa Rican and Honduras specimens are precisely alike in all important characters. . . ." I know of no Nicaragua record for this species, where, however, it would seem that it must occur.

*Trichechus manatus* Linnæus. Well known to have been formerly abundant along the eastern coast.

†12. *Tayassu crusnigrum* Bangs.

Six specimens, 3 adult males, 3 young adult females: Matagalpa, adult male and young adult female, June 19 and 23, 1908; Rio Coco, adult male, Nov. 19, and young female, Nov. 25, 1908; San Rafael del Norte, adult male, Feb. 8, 1909; Pena Blanca, young female, June 4, 1909.

The collector's measurements of total length (the only measurements taken) are as follows: ♂ 1150, ♂ 1170, ♀ 1200; ♀ juv., 970. (Measurements are lacking for one of the males).

The three adult male skulls measure as follows:

No.	Basal length.	Occipito-basal.	Palatal.	Zyg. b'dth.	Upper molars.
28954.	198 mm.	222 mm.	143 mm.	99 mm.	62 mm.
29442.	192 "	330 "	135 "	100 "	62 "
29443.	195 "	330 "	142 "	—	62 "

These specimens agree closely in size, coloration, and cranial characters with Bangs's *Tayassu crusnigrum*, and hence differ widely from any of the known forms of the *Tayassu augulatus* group. I also refer a specimen in the

<sup>1</sup> G. S. Miller, Jr., Proc. Biol. Soc. Washington, XIII, Jan. 31, 1899, p. 4.

Museum collection from the Rio Sixola, Costa Rica, collected by M. A. Carriker, Jr., to *T. crusnigrum*; this is a male; total length, 870 mm.

\**Tayassu pecari* (Fischer). A white-lipped peccary has been recorded from Nicaragua by Alston (Biol. Cent. Amer., I, 1879-1882, p. 109), on the authority of Belt, and by True (Proc. U. S. Nat. Mus., XI, 1888 (1889), p. 467). Whether the form occurring in Nicaragua is the true *T. pecari* or *T. p. ringens* Merriam, is impossible to decide in the absence of specimens.

†13. ***Odocoileus truei* Merriam.**

Four specimens, three adult females and a fawn in spotted coat: Muy Muy (fawn), July 28; Rio Coco, Nov. 30, 1898; Rafael del Norte, Feb. 7, 1909.

[In a paper on mammals from Chiriqui, Panama, collected by the late J. H. Batty, which I published in 1904,<sup>1</sup> I referred certain specimens to *Odocoileus costaricensis* Miller. A reëxamination of this and other material, in part received since 1904, has shown that the Chiriqui specimens are not referable to *O. costaricensis*, but represent merely a mainland form of *O. rothschildi* from Coiba Island. As indicated in my former paper, the specimens from Boqueron, Chiriqui, represent a somewhat larger and paler form than the Coiba Island species, from which it is only subspecifically separable. For this form I propose the name ***Odocoileus rothschildi chiriquensis***, with No. 18957 (♀ ad., Boqueron, Chiriqui, Dec. 4, 1901) as the type. The series of antlers already figured (*l. c.*, fig. 17, p. 64) illustrate not only the form of the antlers in adults but also their variations with age.]

14. ***Mazama tema* Rafinesque (= *sartorii* Saussure).** (Bull., XXIV, 1908, p. 649: Tuma).

Two specimens: adult female, San Juan Telpaneca, Jan. 4, 1909; another adult female, label lost. The January specimen, in winter coat, compared with worn specimens, has the pelage much longer, darker, and more lustrous.

†15. ***Mazama pandora* Merriam.**

An adult female, Pena Blanca, June 8, 1909.

†16. ***Tapirella dowi* (Gill).**

Four specimens, three old adults and one young adult, Rio Tuma, July 10, 1908, and March, June, and October, 1909.

\**Tapirella bairdi* (Gill). Recorded by Selater (P. Z. S., 1871, p. 626) from "Nicaragua."

17. ***Sylvilagus floridanus chiapensis* (Nelson).** (Bull., XXIV, 1908, p. 649: Leon, Chontales, and Ocotal).

According to Mr. Nelson (N. Amer. Fauna, No. 29, 1909, p. 190), these specimens "are perfectly typical *chiapensis* in color, but are smaller, with

<sup>1</sup> This Bulletin, Vol. XX, 1904, pp. 63-66, fig. 17 (horns).

shorter ears and hindfeet." Three additional specimens were received during 1909, as follows: San Rafael del Norte, adult male and female, Jan. 1 and 2, 1909; an adult male, Jalapa, Jan. 25, 1909.

18. *Sylvilagus (Tapeti) gabbi tumacus* (Allen). (Bull., XXIV, 1908, p. 649: Tuma and Ocotal).

Five additional specimens of this well-marked form have been received since the publication of the original description in 1908 (*l. c.*), based on two examples. The months represented are January, March, June, and December; the localities are Matagalpa, Ocotal, Vijagua, Jalapa, and Pena Blanca. Compared with a series of 9 specimens from Costa Rica and Panama, collected in December, April, September, and October, the contrast in coloration is striking, and obviously not due to season, the Nicaragua specimens having the prevailing color of the dorsal surface black (in two the greater part of the back is wholly black), instead of fulvous as in the Costa Rica-Panama series. Only one of the Nicaragua series, a greatly worn June specimen, approaches the average of the other series, but is still much darker than the darkest example of the Costa Rica-Panama series. The buffy gray throat band is also very much darker in the Nicaragua series than in the other series. I cannot help feeling therefore that Mr. Nelson's recent statement<sup>1</sup> that "*Sylvilagus gabbi tumacus* Allen is typical *gabbi* in rich unworn pelage. . . ." is open to reconsideration.

†19. *Agouti paca virgata* Bangs.

Four specimens, adult male and female and two young adults: Rio Coco, Dec. 1, 1908; Vijagua, March 23, 1909.

20. *Dasyprocta punctata* Gray. (Bull., XXIV, 1908, p. 649: Matagalpa and Savala).

Five specimens, all females: Matagalpa, June 22; Rio Coco, Nov. 25, 1908; Vijagua, March 18; Rio Tuma, April 17; Pena Blanca, May 17, 1909.

21. *Coendou mexicanus* (Kerr). (Bull., XXIV, 1908, p. 649: Volcan de Chinandega, Chontales, and Ocotal.)

A young specimen in first pelage, Uluce, July 25, 1909. General color reddish chestnut, slightly paler on the ventral surface of the body, but underside of tail nearly black. The spines are wholly concealed by the fine, soft, short reddish fur, wholly in contrast with the black pelage of the adult animal.

22. *Proechimys centralis* (Thomas). (Bull., XXIV, 1908, p. 649: Rio Grande).

23. *Hoplomys truei* Allen. (Bull., XXIV, 1908, pp. 650-652, figs. 1-4: Savala).

Five specimens, three adult, two about one-third grown: Rio Coco, Dec. 1 and 2, 1908 (young); Vijagua, March 17 and 18, 1909 (adult).

<sup>1</sup> N. Amer. Fauna, No. 29, p. 261, August 31, 1909.

24. *Heteromys vulcani* Allen. (Bull. XXIV, 1908, p. 652: Volcan de Chinandega).

25. *Heteromys fuscatus* Allen. (Bull., XXIV, 1908, p. 652: Tuma, Chontales, and Matagalpa).

Twenty-nine specimens: Vijagua (2), March 24; Rio Tuma (2), April 1; Uluce (12), July 18-31; Matagalpa (1), Oct. 16; Rio Coco (7), Nov. 10-13 and Dec. 1 and 2; Quilali (2), Nov. 1 and Jan. 1; 2 without labels.

[*Heteromys desmarestianus* Gray, described from Coban, Guatemala, and *Heteromys nigrescens* Thomas, described from "Costa Rica," may occur in Nicaragua, particularly the latter.]

†26. *Macrogeomys matagalpæ* sp. nov.

Type, No. 28964, ♂ ad., Pena Blanca, Matagalpa, Nicaragua, June 19, 1908; William B. Richardson.

Similar in general features to *M. cherriei* from Costa Rica, but smaller, the rostrum narrower, and the coloration much darker.

Above very dark brown, considerably darker than seal brown of Ridgway; ventral surface drab; top of head with a large spot of clear white about 20 by 37 mm., a little narrower in front than posteriorly; front and sides of nose buff-drab; a small anal area whitish; feet and tail naked; incisors orange.

Collector's measurements: Total length, 320 mm.; tail, 80; hind foot, 40. Skull, (of type) imperfect, lacking the postorbital portion. Greatest breadth of rostrum, 14; length of nasals, 23. An adult female skull gives the following: Total length, 56; zygomatic breadth, 35.5; mastoid breadth, 29; breadth of rostrum, 13; least interorbital breadth, 9; length of nasals, 21.

In this specimen the mammae are 4, one pair pectoral and one pair in front of thighs, too lateral in position to be called inguinal.

Represented by five specimens, an adult male (the type), an adult female, two young adult males, and one half-grown male; three are from Matagalpa and two are from Pena Blanca. They are very uniform in coloration, all having the conspicuous large white patch on the top of the head; the white anal area, however, is variable, being well marked in three, less distinct in two.

*Macrogeomys cherriei* (Allen)<sup>1</sup> was originally described from a single specimen, of which it was said: "The white patch on the crown is possibly albinism, but if normal is a striking feature." In a later notice of this species,<sup>2</sup> based on five additional specimens, it was added: "They all possess the prominent squarish or subtriangular white patch on the top of the head noted in the type, and thought possibly due to albinism. It proves, however, to be a normal and striking feature of the coloration." The five

<sup>1</sup> Bull. Amer. Mus. Nat. Hist., V, 1893, pp. 337, 338.

<sup>2</sup> *Ibid.*, VIII, 1896, pp. 45, 46, pl. i.

specimens of *M. matagalpæ* are all similarly marked, the white patch being even larger than in *M. cherriei*. In 1895 Dr. Merriam<sup>1</sup> described another member of this group from Costa Rica as *M. costaricensis*, which also has a white spot on the top of the head. This striking feature is thus known to occur in three species of the genus *Macrogeomys*.

As already noted, *M. matagalpæ* is readily distinguishable from *M. cherriei* through its much darker coloration, both above and below, and by its somewhat smaller size. Both are separated from *M. costaricensis* by the structure of the zygomatic arch, as pointed out by Merriam.

27. ***Neotoma chrysomelas* Allen.** (Bull., XXIV, 1908, p. 653: Matagalpa.)

Two specimens: Matagalpa, adult female, April 11; Rio Tuma, young male, April 1, 1909.

28. ***Akodon teguina* (Alston).** (Bull. XXIV, 1908, p. 654: San Rafael del Norte.)

Two specimens: Rio Coco, Nov. 11; San Rafael del Norte, Feb. 3.

29. ***Reithrodontomys modestus* Thomas.** (Bull., XXIV, p. 654: San Rafael del Norte and Savala.)

Eight specimens, mostly without skulls, all taken at San Rafael del Norte, Dec. 31 and Feb. 2-7, 1909. These, in addition to the 7 previously recorded from San Rafael del Norte and Savala, appear to comprise all of the specimens that are positively referable to this species. Those previously recorded (*l. c.*, p. 654) as probably referable (they were without skulls) to this genus are now regarded as young examples of *Oryzomys*.

30. ***Oryzomys* (*Melanomys*) *chrysomelas* Allen.** (Bull., XXIV, p. 654: Savala, Tuma, Chontales, and Rio Grande.)

Fourteen specimens: Vijagua (3), March 19-24; Rio Tuma (5), March 26-April 4; Pena Blanca (3), May 25-27; Rio Coco (3), Nov. 11 and 20.

31. ***Oryzomys couesi* Thomas** (ex Alston). (Bull., XXIV, p. 655: Chontales, Ocotal, San Rafael del Norte, and Tuma.)

Thirty-two specimens: San Juan (1), Jan. 1; Quilali (1), Jan. 14; Rio Tuma (3), April 6; Pena Blanca (6), May 24-June 5; Uluce (1), Oct. 16; Matagalpa (5), Oct. 28 and Jan. 21-25; Rio Coco (12), Nov. 15-Dec. 3; and 3 with illegible labels.

\**Oryzomys richmondi* Merriam, Proc. Washington Acad. Sci., III, p. 284, July 26, 1901. "Type from Escondido River (50 miles above Bluefields), Nicaragua." Very near to, if not the same as, the species recorded in this paper as *Oryzomys couesi*.

32. ***Oryzomys alfaroi* Allen.** (*O. alfaroi* and *O. alfaroi incertus*, Bull. XXIV, p. 655: Chontales, Tuma, and Rio Grande.)

<sup>1</sup> North Amer. Fauna, No. 8, Jan. 31, 1895, p. 192.



Twenty-three specimens: San Juan (6), Jan. 5-8; Jicaro (1), Jan. 16; Jalapa (2), Jan. 22; Pena Blanca (2), June 26, 27; Uluce (2), July 27, 28; Rio Coco (6), Nov. 8-Dec. 3, 1909.

The receipt of this additional material affords evidence that the specimens previously made the basis of *O. alfaroi incertus* may be safely referred to *O. alfaroi*, *O. alfaroi incertus* having been founded on an exceptional and inconstant phase of pelage.

33. **Oryzomys ochraceus** Allen. (Bull., XXIV, p. 655: Rio Grande.)

One specimen, Rio Tuma, April 4.

†34. **Oryzomys richardsoni** sp. nov.

Type, No. 29800, ♂ ad., Pena Blanca, Nicaragua, June 25, 1909; William B. Richardson, for whom the species is named.

Pelage fine, soft and velvety, especially on the ventral surface.

General color above fulvous gray, darker over the median dorsal area, where the prevailing tint is dusky, the blackish-tipped hairs predominating over the pale fulvous tint; below grayish white, the tips of the hairs being whitish, to which the basal gray portion of the pelage imparts a faint tinge of gray. Top and sides of head gray, the tips of the hairs blackish, rendering the head distinctly darker than the back; median dorsal area mixed fulvous and dusky; sides of body less dusky and more fulvous, pale fulvous prevailing; sides of nose, lower part of cheeks, and the whole ventral surface dull white, slightly tinged with gray, but without trace of any buffy tinge; fore arms and hind limbs like adjoining parts of body; feet dull grayish white; ears of medium size, externally dusky like the head, internally pale fulvous; tail dull pale brown, slightly lighter below.

Collector's measurements: Total length, 270 mm.; tail, 150; hind foot, 32.5; ear (dry skin), 13. Skull, total length, 31; length of nasals, 12; upper toothrow, 5; width of brain case, 13; interorbital breadth, 5; zygomatic breadth, 17 (partly estimated, one zygoma being broken). The skull is slender and narrow, with weak dentition, the teeth small for the size of the skull.

*Oryzomys richardsoni* has no close relationship with any hitherto described species from either Mexico or Central America. In texture of pelage it resembles species from northern South America, *e. g.*, *O. mollipilosus*, *O. magdalenæ*, *O. velutina*, etc., with which, however, it requires no close comparison, owing to obvious differences in size and coloration. Unfortunately the species is represented by only the type and a specimen (No. 29544) from Vijagua, a young adult in rather poor condition. This is much smaller, but so similar in color and skull characters that it is provisionally referred to this species.

† 35. **Oryzomys (Oligoryzomys) nicaraguæ** sp. nov.

Type, No. 29543, ♂ ad., Vijagua, Nicaragua, March 24, 1909; William B. Richardson.

Upper parts similar in coloration to that of the upper parts in young-adult examples of *O. fulvescens* and *O. costaricensis* but the general tone much paler, or less rufous and more fulvous; under parts nearly white,—clear white over the pectoral region, grayish white over the abdominal area, where the dusky underfur tinges the surface; feet appreciably lighter and less fulvous; tail darker, nearly black above, slightly paler below.

Collector's measurements: Total length, 180; tail, 110; hind foot, 20. Skull, total length, 21.3; zygomatic breadth, 11; width of braincase, 10; upper premolar-molar series, 3.4.

A second specimen, from San Rafael del Norte, without skull, and referred in my former paper (*l. c.*, p. 654, No. 26) to a supposed (but unnamed) new species of *Reithrodontomys*, seems to belong here.

36. **Sigmodon hispidus griseus** Allen. (Bull. XXIV, p. 657: Chontales.)

Seven specimens: Jalapa (1), Jan. 27; Rio Coco (6), Nov. 30–Dec. 2.

† 37. **Tylomys nudicaudatus** Peters.

An imperfect skin and two skulls, Rio Coco.

38. **Ototylomys fumeus** Allen. (Bull., XXIV, p. 658; Matagalpa, Ocotal, and Volcan de Chinandega.)

Four specimens: Uluce (3), July 26–31; Pena Blanca (1), May 17.

\*\**Nectomys dimidiatus* Thomas, Ann. and Mag. Nat. Hist. (7), XV, June, 1905, p. 586. "Escondido River, 7 miles below Rama, Nicaragua."

39. **Rhipidomys salvini** (Tomes). (Bull., XXIV, p. 658: Ocotal.)

40. **Peromyscus mexicanus saxatilis** (Merriam). (*Peromyscus nicaraguæ*, Bull., XXIV, p. 658: Matagalpa, San Rafael del Norte, Chontales, and Volcan de Chinandega.)

Twenty-nine specimens: Pena Blanca (1), July 7; Uluce (4), July 24–27; Matagalpa (5), Oct. 1–16; Rio Coco (9), Nov. 10–18; San Rafael del Norte (5), Dec. 28–31 and Feb. 5.

This subspecies has a wide range in Nicaragua, extending from the low humid region on both coasts to the highlands of central northern Nicaragua and northward to northwestern Guatemala and adjacent parts of Mexico. Specimens from Jacaltenango, Guatemala, loaned to me for examination from the collection of the Biological Survey, prove on comparison to be indistinguishable from the Nicaragua series and show that Osgood<sup>1</sup> very properly referred *P. nicaraguæ* to *P. mexicanus saxatilis*.

<sup>1</sup> North Amer. Fauna, No. 28, 1909, p. 203.

† 41. *Peromyscus (Baiomys) musculus nigrescens* Osgood.

Two specimens: Matagalpa, Feb. 17; San Rafael del Norte, Feb. 7.

These agree satisfactorily with Osgood's description of this form. They extend the known range of the subgenus *Baiomys* from northwestern Guatemala to the highlands of Nicaragua.

42. *Epimys<sup>1</sup> rattus* (Linnaeus). (Bull., XXIV, p. 659: Matagalpa and Savala.)

Two specimens, Matagalpa, March 11.

† 43. *Mus musculus* Linnaeus.

Four specimens, Matagalpa, Oct. 11 and 20. They are very dark colored, agreeing very closely in color with *M. m. jalapæ* Allen and Chapman, to which they are perhaps referable.

† 44. *Sciurus boothiæ* Gray.

Fifteen specimens, 6 of which are typical *boothiæ*, and 9 intermediate between *boothiæ* and *belti* but nearer the former than the latter. The 6 typical *boothiæ* specimens were taken near the boundary of Honduras, at altitudes of 3000 to 3500 feet, as follows: San Juan (alt. 3500 ft.), Jan. 17; Jicaro (near San Juan), Jan. 16; Jalapa, on the boundary line of Nicaragua and Honduras (alt. 3000 ft.), Jan. 19–24, 1909. These all have the ventral surface pure white, and are otherwise quite uniform in coloration and closely resemble the type of *boothiæ*.<sup>2</sup>

The 9 specimens which grade toward *belti* are all from the Rio Coco, at an altitude of about 800 feet. They differ from the first series in having the suffusion of the dorsal pelage more yellowish, and the white of the ventral surface mainly restricted to the breast and lower abdomen, which regions are mainly white, these two white areas being usually connected by a narrow median line of white. In one adult and one young example the ventral surface, exclusive of the usual white areas, is grizzled dark rufous gray. They were collected November 9, 20, 22, and 30, and December 1, 1908.

45. *Sciurus boothiæ beltii* Nelson. (Bull., XXIV, p. 659: Chontales, Savala, and Matagalpa.)

Seven specimens: Pena Blanca (2) May 25 and 30; Uluce (5) July 25–31. In all of these specimens the ventral surface is deep rufous with irregular patches of white on the breast, axillæ, and lower abdomen. The hind feet vary from black to rufous. Thus in two specimens from Uluce, taken respectively July 25 and July 29, one has the upper surface of the hind feet black with merely a tinge of rufous on the outer edge, while in the other the feet are wholly deep rufous with a small spot at the base of the toes grizzled

<sup>1</sup> Cf. Miller, Proc. Biol. Soc. Washington, p. 58, April 19, 1910.

<sup>2</sup> This series has been examined by Mr. E. W. Nelson and pronounced by him to be "typical *boothiæ*."

with black. Two specimens from Matagalpa and one from Chontales, recorded in my former paper (*l. c.*), have the ventral surface almost entirely deep rufous, and the hind feet mixed rufous and black, in varying proportions in different specimens.

While these specimens are much nearer *belti* than *boothia*, they do not apparently represent the extreme development of the *belti* phase.

46. ***Sciurus variegatoides* Ogilby.** (*Sciurus griseoflavus*, Bull., XXIV, p. 659; in part,—the Matagalpa and San Rafael del Norte specimens.)

In addition to the two specimens from San Rafael del Norte, and the three from Matagalpa previously recorded (*l. c.*), three additional specimens have been since received from San Rafael del Norte, collected Dec. 29, 1908, and Jan. 1, 2, 1909.

The series of five specimens from San Rafael presents a wide range of individual color variation, especially of the feet and ventral surface. The upper surface of both fore and hind feet varies in general tone from silvery white to blackish, the two extremes having been collected respectively in December and April. A specimen taken January 1 has the hind feet blackish, washed over most of the upper surface with grayish fulvous; another taken January 2 has them fulvous tinged with dusky, the blackish basal portion of the hairs showing more or less at the surface; a specimen taken September 28 has the toes and both edges of the feet fulvous, with the upper surface fulvous varied with dusky. This wide range of variation may be largely seasonal, the upper surface of the feet being more or less blackish immediately after the moult and fulvous or whitish in the later fully developed pelage of fall and winter.

This cannot, however, be the case with the ventral surface, which (including inside of limbs) varies from pure white to pale rufous. One of the five San Rafael specimens has the ventral surface entirely clear white; in two others it is white with a narrow pale fulvous lateral line separating the dorsal and ventral areas; in a fourth the inside of the fore limbs is fulvous with a white median line proximally; the throat, fore neck, most of the pectoral region, most of the lower abdomen, and a narrow median ventral line are white; the rest of the ventral surface is fulvous, with irregular patches of pale fulvous on the sides of the pectoral area. The fifth specimen is deep fulvous or pale rufous over the whole ventral surface and inside of limbs except small irregular patches of white on the inguinal and pectoral areas (the latter extending down the inside of the upper arm) and a narrow median ventral line of white.

The two Matagalpa specimens have the feet grizzled grayish fulvous, the toes clear pale fulvous; the ventral surface is white bordered laterally on each side by a narrow band of pale fulvous at the edge of the abdominal

area; the white, however, occupies the inner surface of the hind limbs and the proximal two-thirds of the inner surface of the fore limbs.

The dorsal surface in all is gray varied with black, the gray faintly suffused with buff in six of the specimens, strongly so in the other. The post-auricular patches vary from buffy white (in two specimens) to yellowish buff.

None of these specimens is quite typical of *S. variegatoides*, although the one having the underparts dull yellowish rufous closely approaches Nelson's description (*l. c.*, p. 80) of a specimen which had been compared with the type and pronounced (by Oldfield Thomas) as "identical" with it. The type locality is given by Nelson, on this basis, as San Carlos, Salvador, which is also the type locality of *Macroxus pyladei* Lesson, which Nelson synonymizes (doubtless correctly) with *S. variegatoides*. They appear, however, to agree better with this little-known form than with any other.

† 47. *Sciurus variegatoides adolphei*<sup>1</sup> (Lesson). (*Sciurus griseoflavus*, Bull. XXIV, p. 659, in part — the two Chinandega specimens only).

Volcan de Chinandega, two specimens, ♂ and ♀, March 12, 1907.

These two squirrels do not agree in all particulars with the type specimens of *adolphei*, described by Lesson from Realejo, a locality only about ten miles south of Chinandega, but they agree with *adolphei* in the salient points that distinguish *adolphei* from *pyladei* (true *variegatoides*), from San Carlos, Salvador, the post-auricular patches being pure white instead of reddish buff, and the ventral surface white instead of dark intense buff. The hind feet in one have the upper surface black varied with gray, in the other with pale rufous, instead of brown varied with gray as in *adolphei*; but, as has been shown above, the color of the feet is extremely variable in all the squirrels of this general region, giving to such differences slight significance. Besides, the two Chinandega specimens are practically topotypes of *adolphei*.

Mr. Nelson in his 'Revision of the Squirrels of Mexico and Central America'<sup>2</sup> treats *adolphei* as a full species, basing his description (*l. c.*, p. 73) on a specimen from the "west coast of Nicaragua," without definite locality (at least none is stated), in which he gives the fore legs all around and adjacent part of shoulders and underparts as "dark reddish chestnut" (except chin, throat, axillar and inguinal regions which are white), which is quite at variance with Lesson's description ("Toutes les parties inférieures, le dedans des membres, à partir du menton jusqu'à l'anus, sont d'un blanc pur"). As implied above, the large squirrels of this general region are

<sup>1</sup> *Macroxus adolphei* Lesson, Nouv. Tabl. du Règne Anim., 1842, 112. Realejo, Nicaragua, Central America.

<sup>2</sup> Proc. Washington Acad. Sci., I, pp. 15-110, May 9, 1909.

very unstable in respect to coloration, but it may be noted that the two Chinandega specimens agree better with Lesson's original description than with that given by Nelson, and much better than with the description of *S. variegatoides* as given by Nelson and by Lesson (under *Macroxus pyladei*), these having the post-auricular patches snowy white and the dorsal surface very much more strongly varied with black.

48. **Sciurus (Baiosciurus) deppei matagalpæ** Allen. (Bull. XXIV, p. 660: Matagalpa and San Rafael del Norte.)

Seven specimens: Pena Blanca (3), May 19, 30, and June 7; Rio Coco (2), Nov. 7, 18; San Rafael del Norte (2), Dec. 29, Feb. 5.

In this form the small premolar is often wanting, on one or both sides; when absent its alveolus usually can be recognized, but in several specimens no trace of the former existence of a second premolar remains, as unfortunately is the case with the specimen selected for the type, this fact at the time being overlooked.

49. **Sciurus (Guerlinguetus) richmondi** Nelson. (Bull., XXIV, p. 660: Chontales and Rio Grande.)

Three specimens: Vijagua (1), March 21; Rio Tuma (2), March 25 and April 6.

[*Sciurus (Microsciurus) alfari* Allen. Ranges to northeastern Costa Rica and probably into the adjacent parts of Nicaragua.]

50. **Lutra latidens** Allen. (Bull., XXIV, p. 660: Savala).

One specimen, adult male, Pena Blanca, June 9, 1909. The collector's measurements are: Total length, 1240 mm.; tail, 500; hind foot, 120. In coloration and in other features it closely resembles the type.

The skull, in perfect condition, measures as follows: Condylbasal length, 117; palatal length, 52; zygomatic breadth, 76.5; interorbital breadth, 25; postorbital breadth, 19; postorbital processes, 36; mastoid breadth, 75; upper premolar-molar series, 32.2; lower premolar-molar series, 36.5;  $p^4$ , length on outside, 13; oblique length (antero-internal angle to postero-external border), 14.6;  $p_4$ , length, 15; lower jaw, length 72; angle to coronoid, 35; angle to condyle, 13. The specimen is middle-aged, with the sutures closed but the teeth unworn and the sagittal crest undeveloped; in old age the skull would have been somewhat broader and longer.

The present specimen is of special interest through the presence of a supernumerary tooth on the middle of the palatal area just behind the anterior palatal foramina. It is a slender spicule with an enamel crown, about one-third as large as  $p^1$ .

†51. **Lutra annectens** Forsyth-Major.

One specimen adult male, Rio Tuma, June 15, 1909.

This is of about the age of the specimen recorded under *L. latidens*, but

it is much smaller and otherwise very different. The general color is much lighter throughout, especially below, the chin and throat being grayish fulvous white, much lighter than the rest of the ventral surface; there is, however, a whitish pectoral spot, and a narrow but conspicuous median line of white on the posterior third of the abdomen. The nose pad is pointed or V-shaped on the posterior margin, not straight as in *L. latidens*. The skull also shows marked differences in all the minor details of structure, rendering the specific distinctness of the two forms unquestionable. The external and skull measurements indicate a much smaller animal, while  $p^4$  has the point of the internal cusp about opposite the middle of the tooth instead of much anterior to the middle.

The collector's measurements are: Total length, 1010 mm.; tail, 430; hind foot, 100. The skull measures (*cf.* corresponding measurements of *L. latidens* above): Condylobasal length, 113; palatal length, 45; zygomatic breadth, 68; interorbital breadth, 21; postorbital breadth, 18.5; postorbital processes, 32; mastoid breadth, 65; upper premolar-molar series, 29; lower premolar-molar series, 33.5;  $p^4$ , length on outside, 12; oblique length, 13;  $p_4$ , length, 13; lower jaw, 62.5; angle to coronoid, 31; angle to condyle, 13.

The type locality of *Lutra annectens* is "Terro Tepic, Rio de Tepic, Jalisco, Mexico. Coll. Dr. A. C. Bullen [= Buller], Jan. 1891."<sup>1</sup> There are two skulls in this Museum collected by Dr. Buller in Jalisco, Mexico, so near the type locality as to be in effect topotypes. One is that of an adult male of large size, the other is younger. Comparison of the Nicaragua specimen with these skulls leaves no doubt of their specific identity.

52. ***Putorius tropicalis perdus* Merriam.** (*Putorius tropicalis* Allen, Bull., XXIV, 1908, 661 (not of Merriam.)

Two specimens, both adult males, Matagalpa, July 19, 1908, and San Rafael del Norte, Feb. 2, 1909.

From examination of this and other additional material it is evident that all the Nicaragua specimens should be referred to *P. tropicalis perdus*.

53. ***Tayra barbara inserta* Allen.** (Bull., XXIV, p. 662: Savala, Uluce.)

Five specimens, 2 males and 3 females, all adult: Rio Coco, 1 female, Nov. 13, 1908; Rio Tuma, 2 males, March 11 and April 7; Pena Blanca, 3 females, May 28 and June 6, 1909.

Two agree with former specimens in lacking the throat spot; one (male) has a large prepectoral bright yellow spot, and also a small spot of yellow on the withers; another (female) has a small V-shaped spot of yellow on the throat. Of the 8 specimens received from Nicaragua (all from the lowlands of the east coast) 6 are entirely without the yellow spot on the fore neck.

<sup>1</sup> Ann. and Mag. Nat. Hist. (6), XIX, pp. 618-620, June, 1897.

[The genus *Grison* is represented in Yucatan by *G. canaster* Nelson. As it is a tropical group, probably some hitherto overlooked form occurs in Nicaragua.]

54. ***Spilogale angustifrons elata* Howell.** (Bull., XXIV, p. 662, Matagalpa.)

One specimen, adult female, Jalapa (alt. 4000 feet), on the Honduras boundary, Jan. 24, 1909.

55. ***Mephitis macroura vittata* Lichtenstein.** (Bull., XXIV, p. 662: Matagalpa.)

Five specimens: San Rafael del Norte, 3 males and 1 female, Dec. 31, 1908, and Jan. 1 and 30, 1909; Matagalpa, 1 female, Sept. 27, 1908.

†56. ***Conepatus nicaraguæ* sp. nov.**

Type, No. 29282, ♂ ad., San Rafael del Norte, Nicaragua, Jan. 1, 1909; W. B. Richardson.

Black, with a single broad dorsal white band and a white tail. The white band begins on the forehead at a point in line with the posterior border of the eyes (in two specimens) or considerably posterior to this point (nearly an inch behind in the type specimen). Base of tail black beneath for about an inch, the rest white.

Collector's measurements: total length, ♂ 690 mm. (type), ♂ 690, ♀ 630; tail vertebrae, ♂ 270, ♂ 210, ♀ 260; hind foot, ♂ 80, ♂ 70, ♀ 70.

Skull (type), total length, 79; condylobasal, 68; palatal, 31; zygomatic breadth, 47 (estimated, one zygoma being broken); interorbital, 23; postorbital, 21; mastoid, 39.5; breadth at base of canines, 20; length of upper tooththrow (including canine), 23; length of last molar (outside), 9.3. Adult ♀, total length, 79; condylobasal, 62; palatal, 31; zygomatic breadth, 47; interorbital, 23; postorbital, 21; mastoid, 38.6; breadth at base of canines, 20; upper tooththrow, 23; length of last molar (outside), 9.

The ascending branch of the premaxilla is prominent, and in the female expands posteriorly, being bulb-shaped, with a width near its proximal end of 3 mm.

This species, represented by three specimens, all from the type locality, differs from its geographically nearest known allies, *C. felipensis* and *C. pediculus* Merriam, of southern Mexico, in its much larger size, and especially in the larger size of the last molar, which has a length of 9 mm. on the outer border, instead of 7 and 7.5, respectively, as in the forms from southern Mexico.

57. ***Potos flavus aztecus* Thomas.** (Bull., XXIV, p. 662: Ocotal.)

Seven specimens: Rio Tuma, 1 adult male, April 7; Matagalpa, male and female, April 30; Pena Blanca, 2 males, June 6; Uluce, 2 males, July 20 and 31, 1909.

58. ***Bassaricyon richardsoni* Allen.** (Bull., XXIV, pp. 662-668: Rio Grande, alt. 700 ft.)



No additional specimens have been received, although Mr. Richardson has made special effort to obtain them.

[*Bassariscus sumichrasti* (Saussure), or *B. variabilis* (Peters), if different from *sumichrasti*, doubtless occurs in parts of Nicaragua.]

†59. ***Procyon lotor hernandezi*** (Wagler).

Five specimens, all adult: Jalapa, male and female, Jan. 14 and 23; San Rafael del Norte, 2 males, Jan. 2 and Feb. 4; Vijagua, 1 female, March 22, 1909.

60. ***Nasua narica molaris*** Merriam. (*Nasua narica bullata* Allen, Bull., XXIV, 1908, p. 668 (not of Allen, 1904): Savala and Tuma.)

Eight specimens: Vijagua, 1 male, March 24; Rio Tuma, male and female, April 7; Pena Blanca, male, June 9; Matagalpa, male and female, June 10 and 22; Rio Coco, female, Nov. 9.

These specimens, like the three old males previously received from Nicaragua, are all of the extreme dark phase, except an old female which is light colored throughout. A second female has the top of the head and nape golden rufous, with the dark hairs of the dorsal surface slightly tipped with this tint. A young specimen in first pelage is dark brown above, lighter below.

This series is now referred to *N. n. molaris* rather than to *N. n. bullata*, since the audital bullæ in all are rather smaller than the average size in the *N. narica* group, instead of larger as in *N. n. bullata*. There is, however, a wide range of individual variation in the size and form of the bullæ in all of the forms of *N. narica*. The size of the molariform teeth in the Nicaragua specimens agrees closely with specimens from western Mexico.

61. ***Urocyon cinereoargenteus guatemalæ*** Miller. (Bull., XXIV, p. 668; Matagalpa.)

Four specimens, all adult: Matagalpa, 2 males, Feb. 28 and June 9; San Rafael, 1 (sex and date not given); San Juan, Jan. 5, 1909.

These specimens are larger than the one previously recorded (*l. c.*), and cited as one of the smallest specimens of *Urocyon* on record. One of the male skulls in the present series agrees almost exactly with the measurements of the type of *guatemalæ*; some of the principal measurements are the same, and rarely is the difference in corresponding measurements more than a millimeter. The specimen first recorded of the Nicaragua series is not only markedly smaller than the others, but is white below, the black hairs on the back are more conspicuous, and the color of the ears and adjacent parts is lighter and more golden — apparently all features of individual variation.

†62. ***Felis onca centralis*** Mearns.

Three specimens: Uluce, skin only, July 27; San Rafael del Norte, skin and skull, Feb. 7; also an imperfect flat skin without definite locality.

The three specimens vary considerably in the intensity of the ground color, being brightest (doubtless exceptionally intense) in the flat skin obtained from a hunter. It consists of only the posterior two-thirds of the body portion.

\**Felis bangsi costaricensis* Merriam. Some form of Puma occurs in Nicaragua, as it is mentioned by Mr. Richardson in one of his letters as one of the species he was unable to procure. It is very likely referable to *P. b. costaricensis*.

†63. ***Felis pardalis mearnsi* Allen.** (*Felis costaricensis* Mearns; not *Felis bangsi costaricensis* Merriam.)

Two specimens, adult male and female, collected as follows:

No. 29444, Rio Coco, Nov. 19, 1908, very old male. No external measurements. Ground color of dorsal surface tawny, the markings deep black. Skull with strongly developed sagittal and occipital crests. The skull measures: Condylobasal length, 137; basilar length, 126; zygomatic breadth, 103; interorbital breadth, 30; breadth at postorbital constriction, 28.5; mastoid breadth, 58; upper toothrow (including canine), 43; length of  $p^4$ , 15.5.

No. 29843, Pena Blanca, June 6, 1909; middle-aged female, in the gray phase of coloration; ground color of the dorsal surface dull buffy gray instead of tawny as in the male. The skull is badly broken and hence not available for general measurements. It is somewhat smaller than the very old male skull, as would be expected, the length of the upper toothrow being 38, and the length of  $p^4$  15.1. Collector's external measurements: total length, 1170; tail vertebræ, 360; hind foot, 160.

†64. ***Felis* sp. indet.**

One specimen, No. 28957, adult male, skin and skull, Volcan de Chinandega, Sept. 20, 1908.

Ground color of head, nape, shoulders, middle of dorsal region and fore limbs tawny, sharply marked by stripes and spots of black. Collector's measurements: total length, 1260 mm.; tail vertebræ, 510; hind foot, "60" (doubtless 160). Skull: condylobasal length, 101; basilar length, 90; zygomatic breadth, 72; interorbital breadth, 20; postorbital breadth, 32.5; width of braincase, 48; mastoid breadth, 45; upper toothrow (including canine), 32; length of  $p^4$ , 12. The skull is that of a middle-aged adult, with sagittal crest absent.

This specimen is clearly different from the two referred above to *Felis pardalis mearnsi*. Although the coloration and markings are similar, it is a very much smaller animal, with the tail relatively about twice the length of this member in the other specimens.

† 65. *Felis* sp. indet.

One specimen, No. 29596, adult female, skin and skull. Matagalpa, April 11, 1909.

Ground color of top of head, nape and shoulders pale tawny, fading to still paler behind the withers and on the fore limbs; other parts pale creamy white, in contrast with the usual pattern of intense black stripes and spots. Collector's measurements: total length, 970 mm.; tail vertebræ, 390; hind foot, 110. Skull: condylobasal length, 89; basilar length, 79; zygomatic breadth, 65.5; interorbital breadth, 26.5; postorbital constriction, 35; width of braincase, 47; mastoid breadth, 41; upper toothrow (including canine), 27.5; length of  $p^4$ , 11.

This specimen is a middle-aged female, practically of the same age as the male specimen (apparently a little older) from Volcan de Chinandega (No. 28957), and resembles it in the relative length of the tail, but it is much paler colored throughout, while the skull is much shorter and broader, with the braincase greatly expanded, as wide as in the much larger Chinandega specimen, while the condylobasal length is nearly one-eighth less.

The last five specimens of Cats above recorded seem unquestionably to represent three distinct species; the first three are short-tailed, the last two long-tailed. In the shape of the skull and general coloration, the Chinandega specimen agrees with the two above identified as *Felis pardalis mearnsi*, but is much smaller; the Matagalpa specimen is still smaller, long-tailed, and has a very short, broad skull. The comparative size is well shown by the length of the upper toothrow and length of  $p^4$ , as follows: *mearnsi*, toothrow, ♂, 43, ♀ 38;  $p^4$  ♂, 15.5, ♀ 15.1; Chinandega specimen, toothrow, ♂, 32,  $p^4$ , 12; Matagalpa specimen, toothrow ♀, 27.5,  $p^4$ , 11. The Matagalpa specimen might be considered as the female of the species represented by the Chinandega specimen were it not for the radical difference between the two in the shape of the skull.

In view of our present very imperfect knowledge of the small spotted cats of tropical America, and the many complications of nomenclature involved, it seems unwise to increase the number of names that has already been applied to these little-known cats. The Matagalpa specimen may be specifically the same as the specimen from Realejo, Nicaragua, imperfectly described by Dr. Joseph Wilson under the name *Felis pardalis minutus*.<sup>1</sup> The name *minutus*, however, is preoccupied by *Felis minuta* Temminck (1827). Probably both of the two forms here left unnamed are covered by the name *Felis tigrina* auct., of which the range is commonly given as Mexico and Honduras to Paraguay. Neither of them can be

<sup>1</sup> Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 82.

referred to *Felis pardinoides oncilla* Thomas, described from a Costa Rica specimen (a skin without skull), as they have the nape hairs "reversed," as is usual in ocelots.

*Felis eyra* Fischer and *Felis jaguarundi* Fischer (of authors). Both have a reputed range extending from Texas to Paraguay. Some form of each probably occurs in Nicaragua.

[Two species of *Sorex* (*S. salvini* Merriam and *S. godmani* Merriam) have been described from the high mountains of western Guatemala (9000 to 10,200 feet altitude) which may range into the highlands of Nicaragua.]

66. ***Blarina olivaceus* Allen.** (Bull. XXIV, p. 669: San Rafael del Norte.)

[Other species of *Blarina* occur in Guatemala and Costa Rica, some of which may range into Nicaragua.]

67. ***Rhynchiscus naso* (Wied).** (Bull. XXIV, p. 669: Tuma.)

Ten specimens, Pena Blanca, May 29–31, 1909.

†68. ***Saccopteryx bilineata centralis* Thomas.**

Two specimens, Muy Muy, July 18 and 27, 1908.

69. ***Peropteryx canina* (Wied).** (Bull. XXIV, p. 669: Savala.)

Sixteen specimens: San Juan (13), Jan. 7–9, 1909; Pena Blanca (2), May 21, 24, 1909; Muy Muy (1), July 30, 1909.

*Balantiopteryx plicata* Peters. This species, according to Thomas, "ranges northwards from Costa Rica to Sinaloa, W. Mexico."<sup>1</sup>

[*Balantiopteryx io* Thomas. Described from "Rio Dolores, near Coban, Guatemala."]

\**Didelidurus virgo* Thomas. Type locality, Escazu, Costa Rica; "other specimens from Guatemala," etc. Recorded by Salvin from Pueblo Nuevo, Nicaragua, as *D. alba*.

\**Chilonycteris rubiginosa* Wagner. Recorded by Miller<sup>2</sup> from Chontales, Nicaragua.

*Chilonycteris personata* Wagner. Described from southern Brazil; recorded from Venezuela and Guatemala (Peters).

*Mormoops megalophylla* Peters. Southern Mexico south to northern South America. Dueñas, Guatemala, is the nearest recorded locality.

†70. ***Micronycteris microtis* Miller.**

Seven specimens: Rio Coco, Nov. 8, 1908.

*Micronycteris megalotis mexicana* Miller. Described from Platinar, Jalisco, Mexico. Anderson has recorded<sup>3</sup> specimens from Bogota, Colombia, Dueñas, Guatemala, and Bay of Honduras.

<sup>1</sup> Ann. and Mag. Nat. Hist. (6), XX, Dec. 1897, p. 546.

<sup>2</sup> Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 402.

<sup>3</sup> Ann. and Mag. Nat. Hist. (7), XVIII, July, 1906, p. 54.

*Phyllostomus hastatus panamensis* Allen. Described from Boqueron, Chiriqui, Panama. Miller gives the range of the *P. hastatus* group as "Tropical America, north to Honduras."<sup>1</sup>

*Trachops cirrhosus* (Spix). Recognized as ranging from Mexico southward to Brazil.

*Chrotopterus auritus* (Peters). Described from Mexico and since recorded from Colombia, Brazil, etc., so that Nicaragua is included in its known range.

†71. **Vampyrus spectrum** (*Linnaeus*).

One specimen, Volcan de Chinandega, Aug. 30, 1908.

†72. **Glossophaga soricina** (*Pallas*).

Eight specimens: Volcan de Chinandega (2); Aug. 23, 31, 1908; San Juan (5), Jan. 9; Quilali (1), Jan. 1, 1909.

*Glossophaga mutica* Merriam. Described from the Tres Marias Islands, Jalisco, Mexico; and later recorded from Costa Rica.

*Anoura geoffroyi* Gray. This tropical American species ranges from Brazil north to southern Mexico and is therefore of probable occurrence in Nicaragua.

*Chæronycteris godmani* Thomas. "Guatemala." Perhaps from Champico, where the collector (Champion) obtained *Dichlidurus albus*. (*Cf. Biologia Centr.-Amer.*, Vol. I, p. 207.

[*Chæronycteris mexicana* (Tschudi). Southwestern Mexico and southern Guatemala (Dueñas).]

[*Hylonycteris underwoodi* Thomas. Type locality, Rancho Redondo, Costa Rica.]

*Leptonycteris nivalis* (Saussure). Nicaragua is included within the known range of the species.

\**Lichonycteris obscurus* Thomas. Type locality, Managua, Nicaragua.

73. **Hemiderma perspicillatum aztecum** (*Saussure*). (*Bulletin*, XXXV, p. 669: Matagalpa.)

Twenty-three specimens: Matagalpa (13), June 16–21, 1908; Chinandega (1), Aug. 31, 1908; San Juan (5), Jan. 16–21, 1909; Quilali (3), Jan. 14, 15, 1909; Jalapa (1), Jan. 22.

[*Hemiderma castaneum* (H. Allen). Described from Costa Rica and may occur in Nicaragua.<sup>2</sup>]

*Sturnira lilium* (Geoffroy). This species has an accredited range ex-

<sup>1</sup> Families and Genera of Bats, 1907, p. 130.

<sup>2</sup> In Central American and Mexican specimens of *Hemiderma* the forearm averages about 1 mm. longer, and the metacarpal of the third finger about 2 mm. longer than in specimens from northern Colombia, Venezuela, and Trinidad (true *perspicillatum*), and the coloration averages decidedly brighter and more rufous. *Hemiderma castaneum* (H. Allen) and *H. subrufum* Hahn do not seem to me to be satisfactorily established.

tending from Paraguay to southern Mexico, and without doubt is to be regarded as a Nicaraguan species. There are recent records for Panama and for Mexico.

*Vampyrops helleri* Peters. Described from "Mexico," and since recorded from Chiriqui, Panama, by both Bangs and Allen.

*Vampyrops vittatus* (Peters). Described from Costa Rica and doubtless ranges into Nicaragua.

†74. **Vampyroides caracciolaë** (Thomas).

One specimen, without definite locality, the label having been detached in shipment. This specimen, with others, was submitted to Mr. Gerrit S. Miller, Jr., for identification, who kindly replied as follows: "The larger one [the present specimen] is a *Vampyroides*, and I can see no way to separate it from *V. caracciolaë*. But we have no Trinidad material. Perhaps you are more fortunate." As there is no specimen of this rare species in this Museum, I gratefully accept Mr. Miller's provisional identification.

†75. **Gen. et sp. indet.** A skin, without skull, No. 28336, from Volcan de Chinandega, May 12, 1907.

This bat has also been kindly examined by Mr. Miller, who writes that he does not recognize it, and states that without the skull, he would "not care to hazard a guess." It is a small bat with a simple noseleaf and rather striking coloration, the throat and chest being deep ochraceous and the rest of the lower parts yellowish, brighter on the anal region than on the belly. It doubtless represents an undescribed species and possibly an undescribed genus.

*Chiroderma salvini* Dobson. The type locality of this species is "Costa Rica." It is quite probable that it ranges into Nicaragua.

\**Ectophylla alba* H. Allen. Described from Segovia River, Honduras, and later recorded by the same author<sup>1</sup> from San Emilio, Lake Nic-Nac, Nicaragua.

76. **Artibeus jamaicensis richardsoni** Allen. (Bulletin, XXIV, p. 669: Matagalpa).

\**Artibeus jamaicensis jamaicensis* Leach. Andersen<sup>2</sup> gives the mainland range of this species as "Central America and S. Mexico, as far north as Morelos, and exclusive of Yucatan." He records a specimen from Greytown and another from the "Escondido River, 50 miles from Bluefields," Nicaragua. To this species he will probably refer my recently described *Artibeus jamaicensis richardsoni*, recorded above, with the other forms of this group it seems to have been my misfortune to describe!

\**Artibeus watsoni* Thomas. A specimen of this species is recorded from the Escondido River, Nicaragua, by Andersen (*l. c.*, p. 290).

<sup>1</sup> Trans. Amer. Phil. Soc., n. s., Vol. XIX, 1898, pp. 267-272, pl. xvi.

<sup>2</sup> Proc. Zool. Soc. London. 1908, I, p. 267.

\**Artibeus toltecus toltecus* (Saussure). A specimen is recorded by Andersen (l. c., p. 300) from Jinotega, Nicaragua, and others from Costa Rica, Guatemala, and southern and central Mexico.

*Pygoderma bilabiatum* (Wagner). Said to range from Mexico to Brazil.

*Centurio senex* Gray. There are records of the capture of this rare species, according to Rehn,<sup>1</sup> from Cartago, Costa Rica, and from Guatemala, in addition to localities in the State of Vera Cruz, Mexico. It is therefore of probable occurrence in Nicaragua.

77. *Desmodus rotundus* (Geoffroy). (Bulletin, XXIV, p. 670: Volcan de Chinandega.)

Two specimens: San Juan, Jan. 10; Jalapa, Jan. 20, 1909.

*Diphylla ecaudata* Spix. Has a recognized range extending from tropical America north to southern Mexico.

*Natalus stramineus* Gray. Recognized as ranging from Brazil to Central Mexico.

\**Thyroptera discifera* (Lichtenstein & Peters). Recorded from Bluefields by Miller,<sup>2</sup> who gives its range as Puerto Caballos, Honduras, to Bluefields, Nicaragua.

*Myotis nigricans* Schinz. Ranges north to southern Mexico; undoubtedly occurs in Nicaragua.

*Eptesicus fuscus miradorensis* (H. Allen). Recorded from Panama, Costa Rica, and Guatemala (Miller), and hence should be found in Nicaragua.

\**Eptesicus fuscus propinquus* (Peters). Recorded from Greytown, Nicaragua by Miller.<sup>3</sup>

†78. *Rhogeessa tumida* H. Allen.

Four specimens: Chinandega (1), Aug. 28, 1908; Uluce (3), July 1, 25, 27, 1909.

*Rhogeessa parvula* H. Allen. Described originally from the Tres Marias Islands, west coast of Mexico, and since recorded from Costa Rica.

• *Nycteris* <sup>4</sup> *borealis mexicanus* (Saussure = *frantzii* Peters). Doubtless has a continuous distribution from southern Mexico to Costa Rica and Panama.

*Dasypterus ega panamensis* Thomas. Described from Chiriqui, Panama; probably extends north in the lowlands of Nicaragua, in view of the known distribution of the *D. ega* group.

*Nyctinomus brasiliensis* Geoffroy. The *Nyctinomus brasiliensis* group

<sup>1</sup> Proc. Acad. Nat. Sci. Philadelphia, 1901, p. 298.

<sup>2</sup> Proc. Biol. Soc. Washington, Vol. X, pp. 109-112, pl. vii and text figs. 1-3, July 26, 1896.

<sup>3</sup> N. Amer. Fauna, No. 13, p. 100, Oct. 16, 1897.

<sup>4</sup> On *Nycteris* vs. *Lasiurus* cf. Miller, Proc. Biol. Soc. Washington, XXII, p. 90, April 17, 1909.

ranges from tropical South America to the southern border of the United States, and evidently some form of it must occur in Nicaragua.

*Nyctinomus gracilis* (Wagner). Recognized as ranging from southern Brazil to Guatemala.

*Eumops abraxas* (Temminck). Guatemala to Brazil.

*Promops nasutus* (Spix). Guatemala to Brazil.

79. ***Molossus rufus*** (Geoffroy). (Bulletin, XXIV, p. 670: Volcan de Chinandega.)

*Molossus obscurus* Geoffroy. Guatemala to Bolivia and Paraguay.

80. ***Alouatta palliata*** Gray. (*Alouatta palliata matagalpæ* Allen, Bull., XXIV, p. 670; Savala.)

Four specimens: Matagalpa, adult male, June 20, 1908; Uluce, adult male, July 25; Pena Blanca, adult female and young male, June 10, 1909.

Since describing the Nicaragua form as a subspecies of *palliata*, I have found that Selater states that *Mycetes palliatus* Gray "was originally described from examples procured by M. Sallé (as he himself told me) in Nicaragua, where the animal is found in the islands and on the banks of the lake Nicaragua" (Proc. Zoöl. Soc. London, 1872, p. 7). This renders my *A. p. matagalpæ* a synonym of *A. palliata*. Gray, however, originally gave the type locality as Caraccas, Venezuela.

[*Aotus rufipes* (Selater, Proc. Zoöl. Soc. London, 1872, p. 3, pl. i). The type was a specimen received alive at the menagerie of the London Zoölogical Society, June 12, 1871, and was said to have "been obtained at San Juan del Norte, Nicaragua." The locality was unquestionably erroneous since the genus *Aotus* (= *Nyctipithecus*) is not known to occur north of Panama, while the alleged locality is in the highlands of northern Nicaragua at an elevation of 5000 feet.]

[*Saimiri ærstedii* Reinhardt. Selater has recorded a specimen (P. Z. S., 1874, p. 495), received alive at the menagerie of the London Zoölogical Society, September 5, 1874, as having been "obtained in the Department of Solola, Guatemala, which he says "is a more northern locality than has yet been recorded for the species." This specimen was probably originally from some locality much further south, as there is no other record for the species for Guatemala, nor any from Nicaragua where it was *not* obtained by Mr. Richardson. It may, however, extend from Costa Rica into the low coast districts of Nicaragua.]

81. ***Ateles geoffroyi*** Kuhl. (Bull., XXIV, p. 670: Savala, Tuma, and Uluce.)

Three specimens: Matagalpa, adult male, June 11; Pena Blanca, 2 adult males, June 1 and 4, 1909.



82. **Cebus capucinus** (*Linnæus*). (*Cebus hypoleucus*,<sup>1</sup> Bull., XXIV, p. 670: Savala, Chontales, and Ocotal.)

Two specimens: Muy Muy, adult female, July 18, 1908; Rio Tuma, adult male, March 25, 1909.

#### ERRATA.

*Antea*, p. 6, for **Ursus americanus kenaiensis** read **Ursus americanus perniger**, the name *kenaiensis* being preoccupied by *Ursus kenaiensis* Merriam, 1902.

*Antea*, p. 13, for *Muntiacus* and **Muntiacus** read *Tragulus* and **Tragulus**.

“ p. 15, for **Arctitis** read **Arctictis**.

“ p. 16, for *Arctitis* read *Arctictis*.

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<sup>1</sup> *Cebus hypoleucus* (Humboldt) of authors = *Simia capucina* Linnæus, apud Elliot, this Bulletin, XXVI, 1908, pp. 227-229.



# Article X.—THE NORTH AMERICAN SPECIES OF *NEUROTERUS* AND THEIR GALLS.

BY WILLIAM BEUTENMÜLLER.

## PLATES VIII–XIII.

The present paper constitutes the seventh installment of a series of papers on North American Cynipidæ and their galls which have been published by me in the Bulletin of the American Museum of Natural History.

### *Neuroterus* Hartig.

*Neuroterus* HARTIG, Zeitsch. für Ent., Vol. II, 1840, p. 185. MAYR, Gen. Gallenb. Cynip., 1881, p. 37; CRESSON, Synop. Hymen. N. Am., pt. I, 1887, p. 27; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 50; ASHMEAD, Psyche, Vol. X, 1903, p. 151.

*Spathogaster* HARTIG, Zeitsch. für Ent., Vol. II, 1840, p. 186; MAYR, Gen. Gallenb. Cynip., 1881, p. 37; ASHMEAD, Psyche, Vol. X, 1903, p. 51.

*Ameristus* FÖRSTER, Verh. Zool.-Bot. Gesell. Wien, Vol. XIX, 1869, p. 333; Zool. Record, 1869, p. 322; MAYR, Gen. Gallenb. Cynip., 1881, p. 37.

*Manderstjerna* RADOSZKOWSKI, Bull. Soc. Nat. Moscow, Vol. XXXIX, 1886, p. 304; MAYR, Gen. Gallenb. Cynip., 1881, p. 37.

*Dolichostrophus* ASHMEAD, Trans. Am. Ent. Soc. Vol. XIV, 1887, p. 129; Psyche, Vol. X, 1903, p. 151; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 37.

Head, thorax and scutellum smooth, polished or microscopically cracked. Thorax without grooves or with scarcely evident parapsidal grooves. Scutellum well rounded posteriorly and with a distinct, broad, transverse groove at the base. Antennæ 13–14-jointed in the female, 14–15-jointed in the male. First and second joints short and stout, third joint very long and slender, remaining joints gradually becoming shorter. Abdomen large and subpetiolate in the female, small and with a long petiole in the male. Wings of the male very long, usually shorter in the female. Radial area long and narrow, open or closed at the margin. Areolet large and distinct. Cubitus extending to or nearly to the first cross-vein. Legs smooth, delicate. Claws simple or toothed.

Type: *Neuroterus politus* Hartig.

### *Neuroterus batatus* (Fitch).

*Cynips quercus batatus* FITCH, 5th Rep. Nox. Ins. N. Y. Trans. N. Y. Agricul. Soc., 1858 (1859), p. 810; THOMAS, Trans. Ill. Hort. Soc., 1878 (1879), p. 198; PACKARD, Bull. 7, U. S. Ent. Com., 1881, p. 39; 5th Rep. U. S. Ent. Com., 1890, p. 111.

*Cynips q. batatus* OSTEN SACKEN, Ent. Zeit. Stettin, 1861, pp. 410, 414; Proc. Ent. Soc. Phila., Vol. I, 1861, p. 71; PACKARD, 5th Rep. U. S. Ent. Com., 1890, p.

113; BASSETT, Proc. Ent. Soc. Phila., Vol. III, 1864, p. 684; Can. Ent., Vol. IX, 1877, p. 121; Trans. Ent. Soc. Lond., 1873, p. xx.

*Cynips batatus* OSTEN SACKEN, Proc. Ent. Soc. Phila., Vol. IV, 1865, pp. 340, 344, 350, 353.

*Neuroterus batatus* MAYR, Gen. Gallenb. Cynip., 1881, p. 37; ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, p. 132; Bull. I, Col. Biol. Assoc., 1890, p. 38; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist., Vol. IV, 1892, p. 262, pl. xiii, fig. 1; Am. Mus. Journ., Vol. IV., 1904, p. 107, fig. 41; Ins. Galls Vicin. N. Y., 1904, p. 21; fig. 41; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 40; BRODIE, Ann. Rep. Forest. Ontario, 1896, p. 117, fig. 3; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 50; FELT, Ins. Affect. Park & Woodl. Trees 1906, p. 624.

*Female.* Head black, microscopically reticulated, face with a fine thin pubescens, palpi and mouth parts brown. Antennæ 13-jointed, first three joints yellow, the following ones brown. Thorax jet black, shining, microscopically reticulated. Parapsidal grooves wanting. Anterior parallel lines scarcely evident. Scutellum smooth, shining, microscopically reticulated, with a few scattered hairs; foveæ at base wanting; separated from the thorax by a deep smooth groove. Abdomen black, smooth and shining. Legs yellowish brown, femora dark brown in the middle as are also the hind tibiæ. Wings hyaline, veins brown, cross-veins heavy. Areolet large. Length, 2 to 2.25 mm.

*Male.* Antennæ 14-jointed. Abdomen petiolate. Legs wholly pale yellow. Length, 1.25-2 mm.

*Gall.* (Plate VIII, Figs. 1-8.) On the terminal twigs of young white oak (*Quercus alba*). Polythalamous, hard, woody, uneven swellings, often resembling a potato in shape. They are usually much longer than broad, and often covered with a glaucous bloom. Green in summer and brown in winter.

*Habitat.* Canada; New England and Middle States southward; Ohio; Illinois; westward to Colorado.

There are two annual generations of *Neuroterus batatus*. The first brood appears early in May, from galls of the preceding year's growth, and the second brood in June, from green galls. The second brood oviposits in the galls from which they were produced. Mr. Bassett states (Can. Ent., IX, p. 121) that he reared thousands of *Neuroterus batatus* of both generations, for a series of years, and always with the same results. The early summer brood from the leaf galls was always made up of both sexes in nearly equal numbers, while the brood from the late summer galls came out in the spring, just as the leaves began to appear, and were all females.

### ***Neuroterus noxiosus* (Bassett).**

*Cynips noxiosa* BASSETT, Can. Ent., Vol. XIII, 1881, p. 108.

*Neuroterus noxiosus* MAYR, Gen. Gallenb. Cynip., 1881, p. 37; ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; GILLETTE, 27th Rep. Agricul. Mich. 1888, p. 471; Psyche, Vol. V, 1889, p. 187; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist., Vol. IV, 1892, p. 262; Am. Mus. Journ., Vol. IV, 1904, p. 107, fig. 42; Ins. Galls Vicin.

N. Y., 1904, p. 21, fig. 42; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 44; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51; FELT, Ins. Aff. Pk. & Woodl. Trees, 1906, p. 624.

*Neuroterus noxiosa* ASHMEAD, Trans. Am. Ent. Soc., Vol. XIV, 1887, p. 132.

*Female*. Head black, finely and evenly punctate, mouth part yellowish. Antennæ 13-jointed, first to sixth joints pale yellowish-brown, remaining joints dark brown. Thorax black, shining, apparently smooth, but under a high power lens, showing a fine crackled surface. Parapsidal grooves wanting. Scutellum black, microscopically wrinkled, with a curved groove at the base. Abdomen black, smooth and shining. Legs dark brown, joints and tarsi yellowish. Wings hyaline, veins dark brown and distinct. Areolet small, but sharply defined. Cubitus extending to the first cross-vein. Length, 1.25 to 1.50 mm.

*Male*. Somewhat paler than the female. Antennæ 14-jointed, third joint curved. Abdomen petiolate. Legs wholly yellowish brown. Length 1 to 1.25 mm.

*Gall*. *Winter form*. (Plate IX, Figs. 1-7). On the terminal twigs of swamp white oak (*Quercus platanoïdes*). Polythalamous. Hard and woody swellings varying greatly in shape and size, but usually tuber-like. Internally there are numerous larval cells. Length, 5 to 100 mm. Width, 4 to 25 mm.

*Vernal form*. (Plate IX, Fig. 8). The gall is an enormous development of the mid-rib on the petiole of the leaves. It is green, succulent and irregular in shape. The blade of the leaf becomes dwarfed and curled, and after the galls mature the leaf becomes shriveled and dried.

*Habitat*. New England and Middle States westward to Iowa.

This species is double brooded, the first brood appearing in May from the large woody galls of the previous year's growth, and the second brood in June from galls formed on the leaves and tender twigs.

### ***Neuroterus consimilis* Bassett.**

*Neuroterus consimilis* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 335; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 50.

*Male*. Head black, shining, broader than the thorax. Antennæ 15-jointed, longer than the body, dull brown. Thorax black, microscopically punctate. Parapsidal grooves reduced to two short lines, at the scutellum. Scutellum small, black, punctate, groove at base broad and shining in the middle, abdomen small, black. Legs: Anterior and middle pairs uniform dull yellowish brown, posterior pair nearly black with the joints yellowish brown. Wings hyaline, veins dark and well-defined. Areolet small. Radial area open. Length, 1.50 mm.

*Female*. Black. Parapsidal grooves wanting. Transverse groove at base of scutellum rather broad, shining and smooth. Abdomen large, with the terminal segments retracted within the first which is wide and deep. Posterior legs darker than in the male. Length, 2 mm.

*Gall*. (Plate X, Fig. 3.) On the young terminal twigs of white oak (*Quercus alba*) in midsummer. Polythalamous. Hard and woody, irregularly rounded with aborted buds and leaves. It is a greatly fore-shortened and enlarged branchlet and measures from about 4 to 12 mm. in diameter.

*Habitat*. Connecticut (Waterbury).

The figure of the gall was made from one of the type specimens.

**Neuroterus obtusilobæ (Karsch).**

*Diptolepis q. obtusilobæ* KARSCH, Zeitsch. Gesammt. Naturwiss. Berlin, Vol. V, 1880, p. 292, figs. 3, 3a-b.

*Neuroterus obtusilobæ* DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Body almost smooth, brown-black, the antennæ and legs pale brownish yellow. Thorax nearly without gloss, wrinkled, and almost without sculpture. Scutellum not large. Abdomen shining, smooth. Antennæ 13-14-jointed, slightly thickened at the tip. Areolet of the wing closed. Length, 2 mm.; expanse 5 mm.

*Gall.* (Plate XIII, Fig. 8.) On the tip of the twigs of post oak (*Quercus minor*). Polythalamous. Irregularly rounded or ovate with aborted leaves. Hard and woody with gray brown tint. Inside are many larval chambers.

*Habitat.* Dallas, Texas.

This species is not known to me and the types should be in the Berlin Museum. The figure of the gall on Plate XIII is a copy of Karsch's illustration.

**Neuroterus rileyi (Bassett).**

— RILEY, Am. Ent., Vol. III, 1880, p. 153, fig. 56.

*Cynips q. rileyi* BASSETT, Am. Nat., Vol. XV, 1881, p. 149.

*Neuroterus rileyi* MAYR, Gen. Gallenb. Cynip., 1881, p. 37; ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, p. 132; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 46; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51; COOK, Proc. Iowa Acad. Sci., 1904, p. 225; 29th Rep. Dept. Geol. & Nat. Hist. Indiana, 1904 (1905), p. 837, fig. 30.

*Cynips (Neuroterus) rileyi* PACKARD, 5th Rep. U. S. Ent. Com. 1890, p. 114.

*Female.* Head black, smooth and shining, mandibles yellowish, tips black. Antennæ short, 13-jointed, joints one and two dark amber, third yellowish brown, remaining ones dusky yellowish brown. Thorax small, minutely crackled, shining, with a few pale hairs. Scutellum smooth, rounded with a broad groove at the base. Wings small, hyaline, veins heavy, dark brown. Areolet large and well defined. Radial area long and open. Abdomen subpedicellate, smooth, black and shining. Legs dark brown with pale yellowish joints. Length, 2.75 mm.

*Gall.* (Plate XI, Fig. 11.) On the branches of young chestnut oak (*Quercus prinus*). Abrupt, irregular swellings varying in size and form from round, pustule-like bodies 4 mm. in diameter to a confluent mass of galls about 25 mm. in length and 12 mm. in diameter, containing many larvæ. The larger ones sometimes nearly or quite encircle the twig. They are covered with the bark of the branch and internally they are of a dense cork-like substance. When old and dry they are hard and woody.

*Habitat.* Ohio; Illinois; Indiana; Missouri; Iowa.

***Neuroterus niger* Gillette.**

*Neuroterus nigrum* GILLETTE, 27th Rep. Agric. Mich., 1888, p. 475, fig. 5; Psyche, Vol. V, 1889, p. 218, fig. 5; Proc. Iowa Acad. Sci., 1887-89 (1890), p. 56; *ibid.*, Vol. I, pt. II, 1892, p. 114.

*Neuroterus niger* DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Neuroterus perminimus* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 332; DALLA TORRE and KIEFFER, Ins. Gen. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head, thorax and abdomen very dark, almost black. Antennæ 13-jointed, brown. Parapsidal grooves wanting. Thorax notched posteriorly. Scutellum large, broadly rounded posteriorly and without foveæ. Legs brown, joints and tarsi pale. Wings hyaline, veins brown. Areolet distinct. Radial area long, narrow, closed. Length, 1 mm.

*Male.* Head dark brown. Thorax polished, dark brown. Abdomen reddish brown, very minute and petiolate. Legs pale, semi-translucent. Length .75 mm.

*Gall.* (Plate X, Fig. 1.) In numbers imbedded in the soft parts of the leaf of burr oak (*Quercus macrocarpa*) and white oak (*Quercus alba*). Monothalamous. Rounded or blister-like bodies protruding on both sides of the leaf, but somewhat more distinctly on the upper side; on the under side it has a minute nipple. Diameter 1-1.75 mm.

*Habitat.* Michigan; Ohio; Iowa; Indiana; Illinois; New York; New Jersey; Pennsylvania.

The types of *N. niger* are with Prof. Gillette and in the Agricultural College at Ames, Iowa. The latter were sent to me for examination by Prof. Summers. I fail to find any differences between the flies and galls of *N. niger* and *N. perminimus*, and I consider them one and the same species. The galls of *N. niger* occur on burr oak (*Q. macrocarpa*) and those of *N. perminimus* on white oak (*Q. alba*). The species is double brooded, the first brood emerges early in spring from galls of the previous year's growth, and the second brood appears during the latter part of June and early in July from galls formed by the first brood in May and June. The galls of the latter reach maturity late in August and in September.

***Neuroterus papillosus* sp. nov.**

*Female.* Head broader than the thorax, pitchy brown, shining, mouth parts paler, microscopically crackled, with a few scattered, whitish hairs. Antennæ 13-jointed, pitchy brown, slightly paler basally, and with minute hairs, first and second joints stout, second joint very stout, third and fourth joints long and slender, remaining joints shorter and rather stout. Thorax pitchy brown or almost black, microscopically crackled, shining, and deeply excavated at the hind margin. Scutellum rather large, well rounded posteriorly, shining, pitchy brown or black, with a few hairs. Abdomen similarly colored, smooth. Legs pale, yellowish, pellucid. Wings hyaline, hairy, veins brown. Areolet minute, but distinct. Length .75 mm.

*Male.* Head and body paler than the female, more rufous. Antennæ more yellowish brown, as are also the legs. Length, .75 mm.

*Gall.* (Plate X, Fig. 2.) In numbers on the leaves of swamp white oak (*Quercus platanoïdes* in June. Monothalamous. Elongate oval, blister-like bodies protruding on both sides of the leaf, and without a nipple on the under side. Length about 1 mm.; width about .75 mm.

*Habitat.* Bronx Park, New York City.

The gall is somewhat similar to that of *N. niger*, but is smaller, and lacks the nipple on the under side. The flies emerge during June and early in July, from galls produced in May. The species is undoubtedly double brooded.

#### ***Neuroterus howertoni* Bassett.**

*Neuroterus howertoni* BASSETT, Trans. Am. Ent. Soc., Vol. XVII, 1890, p. 90.

*Neuroterus howertonii* DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 42; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head black or rufous. Antennæ 14-jointed, first joint long, club-shaped, second joint shorter and very stout, third joint long and slender, remaining ones short. All yellowish brown. Thorax, scutellum and abdomen black or rufous, smooth, shining. Legs pale yellowish, middle of tibiæ and femora dark brown. Wings hyaline, veins brown. Areolet large. Length, about .75 mm.

*Gall.* (Plate XI, Fig. 6.) On the under side of the leaves of a species of live oak (*Quercus* sp.). Monothalamous. Rounded, thin-walled cells imbedded in the leaf and covered with a brown pubescence like the rest of the leaf. They occur in numbers upon the leaf and are usually not crowded. On the upper side of the leaf they are slightly less elevated and appear as pustules. Diameter about .50 mm.

*Habitat.* New Mexico.

Bassett described this species as being black in color, but a specimen I cut from one of the type galls is decidedly rufous. It is one of the smallest known species of *Neuroterus*.

#### ***Neuroterus verrucarum* (Osten Sacken).**

*Cynips quercus verrucarum* OSTEN SACKEN, Proc. Ent. Soc. Phila., Vol. I, 1861, p. 62.

*Cynips q. verrucarum* OSTEN SACKEN, Ent. Zeit. Stettin, 1861, pp. 409, 412.

*Cynips verrucarum* OSTEN SACKEN, Proc. Ent. Soc. Phila., Vol. IV, 1865, pp. 340, 344, 348, 355.

*Neuroterus verrucarum* ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, pp. 128, 135; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 47; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Black, shining, mouth parts reddish, antennæ 13-jointed, somewhat incrassated towards the tip, brownish, sometimes brownish black, pale towards the base, especially at the tip of the first two and at the joint. Thorax shining, smooth, not punctate, without any grooves. Abdomen and scutellum black and smooth.



Legs yellowish at the joints; Base of coxæ, middle of femora and tibiæ brown, almost black, tarsi yellow. Wings hyaline, veins brown and thick, second cross-vein curved, almost angular. Areolet rather large and distinct. Cubitus slender, almost obsolete at the first cross-vein. Length, .75–1.25 mm.

*Gall.* (Plate XI, Fig. 5.) In numbers on the under sides of the leaves of post oak (*Quercus minor*) during August and September. Small, wart-like excrescences, densely covered with white crystal-like pubescence. The gall itself is hemispherical with a flat base, and is attached to the leaf by a minute point. Width, 1.50 to 2.25 mm.

*Habitat.* New York; New Jersey; Washington, D. C., south to Florida.

### ***Neuroterus minutissimus* (Ashmead).**

*Cynips q. minutissima* ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. vii.

*Neuroterus minutissimus* ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, p. 128; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 44; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Black, smooth and shining, but showing faint delicate reticulations under a high power lens. Antennæ 14-jointed, yellowish brown, third joint longest. Legs yellowish brown, femora infuscated along the upper surface. Wings hyaline, veins yellowish, radial area open, the tip of subcostal just touches the outer edge, but is not thickened along the edge, radial vein reaches the outer margin. Areolet obliterated. Abdomen black, shining, triangular in outline with prominent, ovipositor sheaths. Length, 1 to 1.25 mm.

*Gall.* (Plate XI, Fig. 4.) On the under sides of the leaves of live oak (*Quercus virginiana*). Monothalamous. Globular and about the size of the head of an insect pin. Attached by a minute point to the leaf and densely covered with coarse, brown, moss-like wool. Diameter, 1.25 to 2.50 mm.

*Habitat.* Florida.

The gall very much resembles externally that of *N. verrucarum*. It occurs in numbers on the same leaf.

### ***Neuroterus floccosus* (Bassett).**

*Cynips floccosa* BASSETT, Can. Ent., Vol. XIII, 1881, p. 111.

*Neuroterus floccosus* MAYR, Gen. Gallenb. Cynip., 1881, p. 37; ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, p. 128; Bull. Col. Biol. Assoc., 1890, p. 38; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist., Vol. IV, 1892, p. 262, pl. xii, fig. 2; Am. Mus. Journ., Vol. IV, 1904, p. 108, fig. 43; Ins. Galls Vicin. N. Y., 1904, p. 22, fig. 43; GILLETTE, Proc. Iowa Acad. Sci., Vol. I, 1892, p. 114; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 41; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51; JARVIS, 37th Rep. Ent. Soc. Ont., 1906 (1907), p. 71.

*Neuroterus exiguiissima* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 332.

*Neuroterus exiguiissimus* DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head, thorax and abdomen shining black. Antennæ 13-jointed, first and second joint stout, third longer than the two preceding ones and very slender, remaining joints also slender, but slightly increasing in thickness towards the last; color pale, dusky yellowish brown. Thorax entirely smooth and without grooves. Scutellum smooth, with a curved groove at the base. Abdomen smooth. Legs dark brown, joints and tarsi pale. Wings hyaline, pubescent, veins rather heavy, brown, cubitus very delicate and almost colorless. Areolet large. Length, 75 to 1.50 mm.

*Gall.* (Plate XI, Figs. 1, 2, 3.) On the under side of the leaves of swamp white oak (*Quercus platanoïdes*) and white oak (*Quercus alba*) in autumn. When mature the gall consist of a rounded cell imbedded in the leaf and thickly covered with whitish wool (fig. 1), showing on the upper side (fig. 2) by a raised, smooth, blister-like projection. Sometimes the galls are confluent and almost cover the entire under surface of the leaf, causing the same to curl and become distorted. When old and dry the wool becomes tawny brown. Diameter, 1.50 to 3.50 mm.

*Habitat.* Canada; New England and Middle States; Ohio; Illinois; Iowa; Colorado (?).

A common species and often nearly all the late terminal leaves of young oaks are covered with the galls. The galls of *Neuroterus exiguissimus* Bassett occur on white oak and they are identical with those of *N. floccosus* which are found on swamp white oak (*Q. platanoïdes*). I also find the flies of *exiguissimus* to be the same as those of *N. floccosus*.

### ***Neuroterus umbilicatus* Bassett.**

*Neuroterus umbilicatus* (BASSETT MS.) BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist., Vol. IV, 1892, p. 263; Am. Mus. Journ., Vol. IV, 1904, p. 108, fig. 44; Ins. Galls Vicin. N. Y., 1904, p. 22, fig. 44 (gall only).

*Neuroterus umbilicatus* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 330; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51; FELT, Ins. Aff. Pk. & Woodl. Trees, 1906, p. 627; JARVIS, 37th Rep. Ent. Soc. Ont., 1906 (1907), p. 72; *ibid.*, 38th Rep. 1907 (1908), pl. B, fig. 6.

*Female.* Head black, smooth. Antennæ 13-jointed, rather short and slender, terminal joints thickened, somewhat club-shaped. Thorax black, polished, without hairs or grooves. Scutellum small, black, without foveæ. Abdomen black, legs clear, dark, shining brown, sometimes nearly black, with the joints paler. Wings hairy, veins pale, first cross-vein dark brown. Areolet small but distinct. Cubitus slender, equal throughout and reaching quite to the first cross-vein. Length, 1.50 mm.

*Gall.* (Plate XIII, Fig. 7.) In great numbers on the underside of the leaves of swamp white oak (*Quercus platanoïdes*) in August and September. Monothalamous. Small, circular, flattened and concave, with a minute conical elevation in the centre of the concavity. Beneath the conical elevation lies the minute larval cell. Brown and covered with minute hairs. The galls are easily detached, but leave an indentation which is seen as a flattened elevation on the upper side of the leaf. Diameter, 1 to 1.50 mm.

*Habitat.* Canada (Ontario); Connecticut; New York; New Jersey; Pennsylvania; Illinois.

***Neuroterus saltatorius* (Hy. Edwards).**

*Cynips saltatorius* Hy. EDWARDS, Pacific Rural Press, 1874, p (?); RILEY, Am. Nat., Vol. X, 1876, p. 218; Trans. St. Louis Acad. Sci., Vol. III, 1878, p. cxcii; Proc. U. S. Nat. Mus., Vol. V, 1883, p. 634; Ann. Mag. Nat. Hist., 5th ser., 1883, p. 142.

*Cynips saltitans* DODGE, Field and Forest, Vol. II, 1876, p. 56, fig.

*Neuroterus saltatorius* ASHMEAD, Trans. Am. Ent. Soc., Vol. XIV, 1887, p. 128; LINTNER, 7th Rep. Inj. Ins. N. Y., 1891, p. 309; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 46; HOWARD, Bull. 54, Bur. Ent., 1905, p. 81.

*Female*. Head pitchy brown black, subopaque, microscopically but distinctly crackled. Antennæ 13-jointed, all the joints rather stout. Thorax pitchy brown, smooth and polished, posterior margin slightly notched. Abdomen blackish, polished. Legs reddish brown. Wings hyaline. Length, .75 mm.

*Gall*. (Plate XI, Fig. 12.) On the under side of the leaves of a species of white oak (*Quercus undulatus*). Rounded, almost globular, attached by a flattened base to the surface of the leaf, apex with a slight point. It is microscopically granulated, thin-shelled, and becomes easily detached. No larval cell. Diameter, .75–1 mm.

*Habitat*. California (Marysville, Yuba Co.).

The article on jumping-galls published by Hy. Edwards in the 'Pacific Rural Press' is not accessible to me and I do not know whether the perfect insect was described. The above description of the gall-fly was made from specimens cut from the type galls. The species has also been recorded from New York, New Jersey, Ohio, Indiana, Missouri and Michigan, occurring on burr oak (*Quercus macrocarpa*), white oak (*Q. alba*), and post oak (*Q. minor*). I believe the latter belongs to another species. The true *saltatorius* is from California.

***Neuroterus cockerelli* sp. nov.**

*Female*. Head, thorax and scutellum black, shining and microscopically crackled and wrinkled, more distinctly so at the sides of the head and thorax. Antennæ 13-jointed, slender, first, second and third joints pale yellowish, remaining joints dusky brown. Thorax without grooves. Scutellum with a broad transverse groove at the base. Abdomen shining, smooth, pitchy brown black or wholly black. Legs: Femora and tibiæ dark brown, joints pale, coxæ and tarsi pale yellowish. Claws black. Wings hyaline, veins distinct, brown. Areolet large. Cubitus reaching the first cross-vein. Length, 1.25 to 1.75 mm.

*Gall*. (Plate XI, Fig. 10.) On the leaves of a species of oak. Hemispherical or subhemispherical, pale brown, minutely crackled, hard and flattened at the base. Width, 4 mm.; height, 2.50 mm.

*Habitat*. Manitou, Colorado (T. D. A. Cockerell).

***Neuroterus longipennis* Ashmead.**

*Neuroterus longipennis* ASHMEAD, Trans. Am. Ent. Soc., Vol. XIV, 1887, pp. 132, 140; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 43; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Black, smooth and shining. Antennæ and legs yellowish. Thorax smooth and without grooves, although in certain lights there are opaque lines. Scutellum swollen, finely rugoso-punctate. Abdomen very small, black and shining. Wings hyaline, very long, radial area open, large and long. Areolet distinct. Cubital cell closed, cubitus being long and pale. Length, 1-1.25 mm.

*Gall.* (Plate XII, Fig. 11.) On the petiole of the leaf or surrounding the base of new shoots of laurel oak (*Quercus laurifolia*), in May. Small, oblong, irregular, woody swellings, measuring from 8 to 9 mm. in length and 3.50 to 4 mm. in diameter.

*Habitat.* Florida.

### ***Neuroterus tectus* Bassett.**

*Neuroterus tectus* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 331; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head black, microscopically crackled and with a distinct facial ridge, mouth parts pale yellowish. Antennæ 13-jointed, rather stout, dark brown, pale at the base. Thorax, scutellum and abdomen black or dark brown, smooth and shining. Legs translucent brown, joints and tarsi pale. Wings hyaline, veins distinct but not heavy. Areolet large. Cubitus reaching the first cross-vein. Length, .75 to 1 mm.

*Male.* Color as in the female. Antennæ 14-jointed, somewhat paler. Abdomen petiolate.

*Gall.* (Plate XII, Figs. 1, 2.) On the small twigs of dwarf chestnut oak (*Quercus prinoides*) in May and June. The gall is very conspicuous and is in shape of an enlargement of the base of the young branchlet. In some cases the galls hardly increase the size of the branch or interfere with its growth while in others it entirely checks its extension.

*Habitat.* Connecticut; New York; New Jersey; Pennsylvania.

### ***Neuroterus virgens* Gillette.**

*Neuroterus virgens* GILLETTE, Ent. News, Vol. IV, 1893, p. 166; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 52.

*Male.* "Head black, and shining; under a power of seventy-five diameters the surface has a finely crackled or scaled appearance as has also the mesothorax; ocelli medium size, face with a median ridge; antennæ 13-jointed, gradually thickened to the tip, first three joints yellowish, third joint longest, first and second joints much thickened; mandibles reddish, but black at the tips; mesothorax shining without parapsidal grooves, broadly notched at the base of the scutellum; scutellum with shallow groove at base, the surface appearance the same as that of the thorax and head. Wings a little longer than the entire body, radial nervure long and narrow, areolet medium size, radial nervure reaching or nearly reaching the costal margin. Feet with tarsi yellowish brown, tibiæ usually of the same color, but in some cases almost black, femora blackish in the middle and sometimes almost entirely black, coxæ always black at the base, but light at the tip. Length, 1.50 to 2 mm." (C. P. Gillette.)

*Gall.* "This species can hardly be said to produce a gall. The cells of the flies were found in the spring of the year in twigs of last summer's growth. The twigs are usually slightly swollen where the cells occur, but not enough to attract

attention. I should not have noticed them at all had I not seen dead twigs with numerous small punctures in them, from which flies had escaped during previous years." (C. P. Gillette.)

*Habitat.* Manitou, Colorado; May 8.

This species is not known to me and the types are with Prof. Gillette. The gall undoubtedly occurs on oak.

### ***Neuroterus minutus* (Bassett).**

*Cynips minuta* BASSETT, Can. Ent., Vol. XIII, 1881, p. 96.

*Neuroterus minutus* MAYR, Gen. Gallenb. Cynip., 1881, p. 37; ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, p. 131; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 44; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Male.* Very pale, semi-translucent, yellowish brown, with the top of the thorax darker and in some specimens showing three longitudinal pale yellowish bands. Eyes and ocelli black. Antennæ 14-jointed, first three joints very pale, remaining ones dusky. Abdomen dark brown, petiole pale, yellowish. Scutellum small, smooth and shining. Legs very pale, claws dark brown. Wings hyaline with a slight smoky tinge, veins distinct. Areolet distinct. Length, .75 to 1.50 mm.

*Female.* Head, thorax and abdomen dark brown. Antennæ 13-jointed, color as in the male. Length, .75 to 1 mm.

*Gall.* (Plate XII, Figs. 3, 4, 5.) On the petiole and midrib of the leaves of white oak (*Quercus alba*) very early in spring when the leaves begin to expand. They occur in clusters and stunt the growth of the leaves. The gall itself is composed of a number of cells in the leaf and is covered with a pinkish pubescence.

*Habitat.* Connecticut; New York; New Jersey; Pennsylvania.

### ***Neuroterus distortus* Bassett.**

*Neuroterus distortus* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 336; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head black or pitchy brown, face very broad with a distinct median ridge. Eyes black opaque. Antennæ 13-jointed, brown, paler basally. Thorax pitchy brown or black, very glossy, high and smooth, and without grooves. Scutellum large, well rounded and separated from the thorax by a deep shining groove. Abdomen brown or black, smooth and shining. Legs clear pale yellowish brown, semi-transparent, femora slightly darker in the middle. Wings hyaline, slightly dusky, veins brown and distinct. Areolet large. Length 1 to 1.50 mm.

*Male.* Similar to the female in color. Antennæ 14-jointed. Abdomen distinctly petiolate. Length, 1-1.50 mm.

*Gall.* (Plate XII, Fig. 6.) On the tips of young branchlets of swamp white oak (*Quercus platanooides*) in May. Polythalamous. The gall consists of oval or rounded chambers in the bud or on the very young leaves which are often curled and distorted. The tip of the twig becomes dwarfed in length and turned to one side. The galls are very inconspicuous and would escape notice were it not for the rosette-like cluster of leaves surrounding them. The capsules measure about .50 mm. The figure of the gall on Plate XII, is enlarged.

*Habitat.* Connecticut; New York; New Jersey.

**Neuroterus pallipes Bassett.**

*Neuroterus pallipes* BASSETT, Trans. Am. Ent. Soc., Vol. XVII, 1890, p. 89.

*Neuroterus bassetti* DALLA TORRE, Wien. Ent. Zeit., Vol. XI, 1892, p. 131; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 40.

*Neuroterus pallidipes* DALLA TORRE, Wien. Ent. Zeit., Vol. XI, 1892, p. 131; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head black and shining. Antennæ 13-jointed, pale brown at the base, growing dusky toward the tips. Thorax smooth, shining. Scutellum smooth with a transverse groove at the base. Abdomen black. Legs almost colorless. Wings hyaline, veins distinct, but not heavy. Areolet large, bounded by slender veins. Cubitus reaching the first cross-vein. Length, 1.25 mm.

*Male.* Color of the female. Legs brown or brownish in the middle of the tibiae and femora. Abdomen petiolate. Length, 1.25 mm.

*Gall.* (Plate XII, Fig. 10.) On the midrib or principal veins of the leaves of white oak (*Quercus alba*) in May. Monothalamous. Small, oval, thin-walled swellings covered with a dense brownish pubescence. The affected leaves become distorted and dwarfed.

*Habitat.* Massachusetts; New York; New Jersey.

Dalla Torre erroneously states that Bassett described this species as *Neuroterus pallidipes* and that the name was preoccupied by *Neuroterus pallidipes* Schenck (Jahrb. Ver. Naturk. Nassau, Heft, 17-18, 1862-63, p. 194). Neither of these authors described a species under this name, but both did describe a *Neuroterus pallipes*. I have retained Bassett's name because Schenck's species appears to be an *Andricus*.

**Neuroterus vernus Gillette.**

*Neuroterus vernus* GILLETTE, Bull. 7, Iowa Agricul. Exp. Sta., 1889, p. 281; Ent. Am., Vol. VI, 1890, p. 22; Proc. Iowa Acad. Sci., Vol. I, pt. II, 1892, p. 114; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 47; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head black, apparently smooth, mouth parts brown, tip of palpi black. Antennæ 13-jointed, first and second joints short and stout, third joint very long, remaining joints short, joints one to three pale, remaining ones dusky brown. Thorax polished, black, mesothorax notched posteriorly. Scutellum smooth, with a groove at the base. Abdomen black. Legs brown, joints pale. Claws black. Wings hyaline, veins very pale. Areolet large. Cubitus continuous to the first cross-vein. Length, 1 to 1.30 mm.

*Gall.* (Plate XII, Figs. 8, 9.) In numbers on young leaves or catkins of burr oak (*Quercus macrocarpa*) in May and June. The galls are enlargements of the petiole, midrib or soft parts of the leaves, dwarfing and deforming them. When on the catkins, these become much enlarged and irregularly swollen, and remain green upon the tree until the flies within have completed their growth.

*Habitat.* Iowa.

According to Prof. C. P. Gillette the eggs are deposited early in April and the galls resulting from the eggs deposited at this time begin to give a second brood of flies May 16. The second brood of flies bred from June galls by Prof. Gillette differs from those of the first brood by having more light colored parts. The base of the mandibles, first three or four joints of the antennæ and feet are distinctly lighter colored. In some cases the anterior tibiæ and the greater part of the anterior femora are distinctly whitish, and the antennæ are distinctly 13-jointed. The male is unknown. The figures of the galls on Plate XII were made from type specimens sent to me by Prof. Gillette. Figure 8 is much enlarged.

### *Neuroterus pallidus* Bassett.

*Neuroterus pallidus* BASSETT, Trans. Am. Ent. Soc., Vol. XVII, 1890, p. 88; BEUTENMÜLLER, Am. Mus. Journ., Vol. IV, 1904, p. 107, fig. 40; Ins. Galls Vicin. N. Y., 1904, p. 21, fig. 40; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 45; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head: Vertex and posterior portion varying from dark brown to almost black, face pale yellowish brown. Antennæ 13-jointed, pale yellowish basally, gradually changing to brown. Thorax notched posteriorly, dark brown, smooth and shining, sides pale brown. Scutellum brown, smooth and shining, with long, transverse groove at the base. Abdomen rather large, black or almost black, smooth and shining. Legs pale, translucent, yellowish, claws black. Wings hyaline, veins dark brown. Areolet large. Cubitus rather delicate and almost reaching the first cross-vein. Radial area open. Length, .75 to 1 mm.

*Male.* Head pale yellowish brown, eyes and ocelli black. Antennæ 14-jointed, pale yellowish basally, dusky terminally. Thorax pale brown with two yellowish longitudinal lines. Pleuræ and legs wholly pale yellowish brown, claws dark. Abdomen pale brown dorsally, paler beneath, petiole short. Length, .75 to 1 mm.

*Gall.* (Plate XII, Fig. 7.) In dense clusters at or near the ends of the aments of swamp white oak (*Quercus platanoïdes*), early in spring. Monothalamous. Round, smooth and unevenly globular. Pale faded wood color and of a fine soft cellular consistence. They are fragile and may be easily crushed.

*Habitat.* New York; New Jersey; Connecticut.

A distinct species readily known by its pale color. The gall is also very characteristic and may be easily known from other species found on the sterile flowers of the oaks.

### *Neuroterus exiguus* Bassett.

*Neuroterus exiguus* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 333; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head black, almost smooth, shining. Antennæ 13-jointed, first large, stout, pointed at base, second as broad as the first, remaining joints slender, all semi-

translucent clear yellowish. Thorax black or pitchy brown, smooth, glossy and without grooves. Scutellum black or brown with a few microscopic hairs and an incurved, broad groove at the base. Abdomen black, or pitchy brown and shining. Legs dark brown with the joints paler. Wings hyaline, slightly dusky and pubescent. Radial area open, areolet large. Length, 1.50 mm.

*Male.* Similar to the female in color. Antennæ 14-jointed, all slender and delicate, except the first and second. Abdomen petiolate. Length 1.50 mm.

*Gall.* On the flower clusters of post oak (*Quercus minor*) in May. These galls are nodular enlargements but all more or less hidden in the flowerlet. They are very small and succulent and soon shrivel up and disappear after the flies have emerged.

*Habitat.* Connecticut; New York; New Jersey (Lakehurst).

The adult of this species is closely allied to *N. tectus*.

### *Neuroterus laurifoliæ* Ashmead.

*Neuroterus laurifoliæ* ASHMEAD, Trans. Am. Ent. Soc., Vol. XIV, 1887, pp. 128, 140; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 42; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Black, smooth and shining. Antennæ pale yellowish brown. Abdomen large, black and shining, almost globose. Legs pale yellowish with the tibiae and femora more or less infuscated in the middle, black or brown. Wings hyaline, radial area open, very long and narrow. Areolet large. Cubital cell open. Length, about 1.50 mm.

*Gall.* (Plate XI, Fig. 7, 8.) On the upper or under sides of the leaves of laurel oak (*Quercus laurifolia*). Monothalamous. Small, rounded, kernel-like with the disk flattened and attached to the leaf by a nipple-like point. The gall is covered with long, loose fawn-colored wool. Sometimes several galls occur upon the same leaf and the wool covering these forms a large, loose mass. When dry the galls and wool become readily detached from the leaves. Diameter of kernel 2 to 2.50 mm.

*Habitat.* Florida; Illinois.

### *Neuroterus dubius* Bassett.

*Neuroterus dubia* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 335.

*Neuroterus dubius* DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head black, vertex microscopically cracked. Antennæ 14-jointed, joints 1 to 4 pale yellowish red. The remaining joints dusky reddish brown; joints one and two equal, third longer, fourth short, remaining ones very short. Thorax high and rounded, scarcely smooth, but shining, with two divergent grooves from the scutellum to the base of the wings. Scutellum finely and evenly rugose, with a broad groove separating it from the thorax. Foveæ wanting. Abdomen shining, black. Legs pale yellowish. Wings dusky hyaline, veins slender. Areolet large. Radial area open. Length, 1.50 mm.

*Male.* Antennæ 15-jointed, joints one and two shorter than in the female, first at base dark and shining, third joint long, pale brown, remaining joints short and



dark brown, opaque. Head, thorax and scutellum and the petiolate abdomen, black. Legs pale but less so than in the female. Otherwise like the female. Length, 1.50 mm.

*Habitat.* Connecticut (Waterbury).

The gall of this insect is unknown. The insects were found by H. F. Bassett in a box of galls of *Andricus pruinosus*, but no galls appeared from which they seemed to have come.

### ***Neuroterus vesiculus* (Bassett).**

*Cynips vesicula* BASSETT, Can. Ent., Vol. XIII, 1881, p. 97.

*Cynips affinis* BASSETT, Can. Ent., Vol. XIII, 1881, p. 103.

*Neuroterus vesicula* MAYR, Gen. Gallenb. Cynip., 1881, p. 37; ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, p. 131; GILLETTE, 27th Rep. Agricul. Michigan, 1888, p. 471; Psyche, Vol. V, 1889, p. 188; Proc. Iowa Acad. Sci., Vol. I, pt. II, 1892, p. 114; DALLA TORRE, Cat. Hymen., Vol. II, 1892, p. 48; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 52.

*Neuroterus affinis* ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, p. 131; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 37; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 50.

*Female.* Head black, finely rugose, ocelli large. Antennæ 14-jointed, yellowish brown basally changing to brown-black toward the tip. Thorax black, very finely and evenly punctate. Parapsidal grooves traceable but not deep. Anterior parallel lines obliterated or scarcely evident in certain lights. Scutellum somewhat shining, punctate and separated from the thorax by a broad, shining groove. Abdomen black, shining. Legs yellowish brown, basal half of femora sometimes somewhat darker, coxæ blackish. Wings dusky, hyaline, long, veins dark brown, cross-veins heavy. Cubitus reaching the first cross-vein. Areolet large and distinct. Length, 1.75 to 2.25 mm.

*Male.* Color as in the female. Antennæ 15-jointed, usually wholly dark brown. Legs somewhat paler. Wings longer. Abdomen petiolate. Length, 1.50 to 2 mm.

*Gall.* (Plate X, Figs. 4, 5, 6.) In the buds of white oak (*Quercus alba*), dwarf chestnut oak (*Quercus prinoides*) and swamp white oak (*Quercus platanooides*), usually partly hidden in the scales of the bud, sometimes standing out round and free like a blister on the twig. Monothalamous, round, thin-walled and of a dark brown or greenish brown color, sometimes with grayish spots. In size it is only large enough to hold the larva within.

*Habitat.* Connecticut; New York; New Jersey; Illinois; Michigan; Iowa.

The galls of this large species of gall-fly are half grown in the autumn and develop so rapidly in the spring that the insects come out just as the leaves begin to expand. I can find no differences between the adults and galls of *N. affinis* (Plate X, Figs. 7, 8, 9) and *vesiculus*, and they are, as surmised by Bassett, one and the same species. It is a distinct species and may be readily known by its large size, punctate thorax with slight traces of par-

apsidal grooves. Mr. Lewis H. Weld, Evanston, Illinois, has bred this species from swamp white oak (*Quercus platanoides*). I have taken the galls in the vicinity of New York late in April. The flies begin to emerge about May 6.

### ***Neuroterus congregatus* Gillette.**

*Neuroterus congregatus* GILLETTE, Ent. News, Vol. IV, 1893, p. 166; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 50.

*Male*. "Head black, shining, with a fine crackled appearance, eyes large and prominent; face narrow and rectangular in outline. The inner margin of the eyes as seen in front being straight and parallel; mandibles reddish yellow, ocelli rather prominent and slightly elevated. Thorax smooth and shining, with the fine crackled appearance common to the genus, without any signs of parapsidal or other grooves, and with a broad notch at the base of the scutellum; scutellum without foveæ, but with a shallow basal groove, shining, and with the crackled appearance indistinct, especially on the central portion. Abdomen petiolate, black. Feet dark brown, light on the joints. Wings 3 mm. long, radial cell long and narrow, radial nervure almost attaining the costal margin, cubital nervure faint, and hence the areolet rather indistinct, all the nerves dark brown. Antennæ 14-jointed, joints 1-3 and often the basal portion of the fourth light yellow, remaining joints brown or blackish; first and second joints robust, third as long as the fourth and fifth together. Length, 2 mm." (C. P. Gillette.)

*Gall*. On the terminal and probably axial bud of oak (*Quercus* sp.). The twig expands next to the bud, and within the bud develop a number of little globular capsules covered and surrounded by a hairy or wooly growth. The capsules resemble those of *N. vesicula* Bass. They are in clusters composed of from ten to fifteen capsules. The clusters measure from 6 to 8 mm. in diameter.

*Habitat*. Colorado (Manitou).

This species is not known to me. According to Prof. C. P. Gillette the galls are found early in May and the flies hatch before May 17. The types are with Prof. Gillette.

### ***Neuroterus clarkeæ* sp. nov.**

*Female*. Head jet black, shining and microscopically crackled. Antennæ 14-jointed, first three joints pale, remaining ones brown black. Thorax jet black, highly polished and smooth, posterior margin slightly excavated. Scutellum minutely rugose, less polished than the thorax, with a few hairs and a transverse groove. Abdomen jet black, shining. Legs amber yellow, pellucid. Wings hyaline. Radial area closed. Cubitus not reaching the first cross-vein. Areolet minute, but distinct. Length, 1.25 mm.

*Male*. Jet black, legs somewhat darker than in the female. Antennæ 15-jointed. Scutellum smooth. Abdomen with a very short petiole.

*Gall*. (Plate XII, Figs. 12, 13.) On the edge of the leaf of white oak (*Quercus alba*) in May. Monothalamous. Light brown, bud-like and covered with short

wool. It is thin-shelled, fragile, and contains no separate larval cell. Length, 2-3 mm.

*Habitat.* Massachusetts (Magnolia).

A fine and distinct species kindly sent to me by Miss Cora H. Clarke. The flies emerge during the latter part of May and early in June.

### *Neuroterus gillettei* Bassett.

*Neuroterus gillettei* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 334; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Female.* Head, thorax and scutellum shining black and smooth. Scutellum with a broad groove at the base. Antennæ 13-jointed. Abdomen rather small, almost black. Legs pale, shining translucent brown in the middle of the femora and tibiæ. Wings subhyaline, hairy, veins distinct and yellowish brown. Areolet large. Cubitus distinctly reaching the first cross-vein. Length, .75 to 1 mm.

*Male.* Black. Antennæ 14-jointed, first joint dark brown, short, second ovate, very pale, third joint long and slender, fourth to last very short, all pale in color. Abdomen petiolate, petiole pale, following segments dark. Length, .75 to 1 mm.

*Gall.* On the petioles and mid ribs of the leaves of post oak (*Quercus minor*). Polythalamous pustule-like and quite irregular in shape and size. When dry the galls are much shrunken and distorted.

*Habitat.* Connecticut (Waterbury); New Jersey (Lakehurst).

### *Neuroterus fragilis* Bassett.

*Neuroterus fragilis* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 335; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Male and Female.* Head and thorax smooth, pale, semitranslucent brown. Abdomen dusky brown, petiolate in the male and very minute. Antennæ 14-jointed in the female, first joint small and short, second large, following joints very short; 15(?)-jointed in the male. Legs very pale. Wings subhyaline, veins distinct. Areolet present. Radial area open. Length, .75 mm.

*Gall.* (Plate XIII, Fig. 1.) On the leaves of a species of oak. Polythalamous. Pale yellowish green irregular swellings on the leaves usually on the midribs. When dry they are hard and pithy.

*Habitat.* California (San Diego).

### *Neuroterus quercicola* Dalla Torre.

*Neuroterus politus* BASSETT, Trans. Am. Ent. Soc., Vol. XVII, 1890, p. 89.

*Neuroterus quercicola* DALLA TORRE, Wiener, Ent. Zeit., Vol. XI, 1892, p. 131; Cat. Hymen., Vol. II, 1893, p. 46; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Male.* Head black; antennæ 14-jointed, first and second joints pale yellow, remaining ones yellowish brown, all very slender. Thorax without furrows or grooves; thorax and abdomen black and very smooth; scutellum separated from the mesothorax by a smooth, shining furrow; a few scattered hairs on the posterior half of the scutellum. Abdomen long petiolated, second segment small, the remain-

ing ones very small. Legs pale yellow. Wings large, veins brown, slender, the cubitus reaching the first cross-vein and of equal size throughout. Areolet very small. Radial area large, long and open.

*Gall.* On the midribs of the leaves of oak (*Quercus undulata*?). Polythalamous, elongate swellings with the larval cells perpendicular to the surface of the leaf. Length 18 mm., width 9 mm.

*Habitat.* Southern Utah.

This species is not known to me. The types are in the American Entomological Society. According to Bassett the galls might be easily taken for those of *Andricus nigræ* or *Andricus tumifica*. Bassett's name *N. politus* is preoccupied by *N. politus* Hartig, a European species.

### ***Neuroterus irregularis* (Osten Sacken).**

*Cynips quercus irregularis* OSTEN SACKEN, Proc. Ent. Soc. Phila., Vol. I, 1861, p. 65.

*Cynips q. irregularis* OSTEN SACKEN, Ent. Zeit. Stettin, 1861, pp. 409, 413.

*Cynips irregularis* OSTEN SACKEN, Proc. Ent. Soc. Phila., Vol. IV, 1865, pp. 340, 344, 349, 353.

*Neuroterus irregularis* ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, p. 129; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 42; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Male.* Head very dark brown, smooth and shining, mouth part pale yellowish. Antennæ 14-jointed, first and second joints stout, third joint very slender, somewhat curved and longer than the first and second together. First, second and third joints very pale, semitranslucent yellow, remaining joints short and dark brown. Thorax reddish brown above, pale beneath, smooth and shining. Scutellum rather large, smooth and shining with a curved groove at the base. Abdomen petiolate, dark brown. Legs very pale semitranslucent yellowish, claws blackish brown. Wings subhyaline, veins broad, radial cell long, rounded at tip. First cross-vein with a pale brown cloud. Length, 2 mm.

*Female.* Head, thorax and abdomen dark pitchy brown. Abdomen not petiolate and with the ventral sheath long. Antennæ 13-jointed. Legs very pale. Length, 1.50 to 1.75 mm.

*Gall.* (Plate XIII, Figs. 2, 3.) On the leaves of post oak (*Quercus minor*) and white oak (*Quercus alba*) during the latter part of May and early in June. Polythalamous. Succulent. Irregular in shape, somewhat flattened and projecting on both sides of the leaves. Yellowish in color and when dry are of a soft pithy substance, enclosing a number of hollow kernels in which the larvæ live.

*Habitat.* Massachusetts; Connecticut; New York; New Jersey; Maryland; Virginia and southward.

### ***Neuroterus majalis* (Bassett).**

*Cynips q. majalis* BASSETT, Proc. Ent. Soc. Phila., Vol. III, 1864, p. 682.

*Cynips majalis* OSTEN SACKEN, Proc. Ent. Soc. Phila., Vol. IV, 1865, pp. 340, 344, 349.

*Neuroterus majalis* MAYR, Gen. Gallenb. Cynip., 1881, p. 37; ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; *ibid.*, Vol. XIV, 1887, pp. 129, 139; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 44; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

*Dolichostrophus majalis* ASHMEAD, Trans. Am. Ent. Soc., Vol. XIV, 1887, p. 129; Psyche, Vol. X, 1903, p. 151.

Allied to *Neuroterus irregularis* in color; in markings and structure it is the same, and the only perceptible difference that I can find between the two species is in size. Length of male, 2.25 to 2.50 mm., of female, 2.25 mm.

*Gall.* (Plate XIII, Figs. 4, 5, 6.) On the leaves of white oak (*Quercus alba*) and chestnut oak (*Quercus prinus*) in May and June. Polythalamous. Very irregular in shape, flat, green and succulent. When dry, light brown and pitch-like. Diameter 6 to about 25 mm. Vertical diameter 6 to 9 mm.

*Habitat.* Massachusetts; Connecticut; New York; New Jersey; south to Florida.

### *Neuroterus flavipes* Gillette.

*Neuroterus flavipes* GILLETTE, Bull. 7, Iowa Agricul. Exp. Sta., 1889, p. 281; Ent. Am., Vol. VI, 1890, p. 21; Proc. Iowa Acad. Sci., Vol. I, 1892, p. 114; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 41; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 51.

Female. "Head entirely black, face very sparsely set with gray hairs and finely rugose; vertex, genæ and occiput finely rugose. Antennæ 13-jointed, first two joints stout and nearly equal in length, third joint longest, fourth to thirteenth subequal in length, the last six or seven forming a slight club; color, light yellow. Thorax black, finely rugose, densely pitted on the shoulders and very thinly set with short gray pubescence. Two shining black, parallel lines begin at the collar and run back half way to the scutellum. Parapsidal grooves shallow and can be traced about two thirds of the way from the scutellum to the collar. Outside of each parapsidal groove is a short depressed line beginning near the base of the scutellum and running parallel with the groove past the base of the wing. Scutellum entirely black, densely pitted and with two shallow foveæ that are almost obsolete. Legs light yellow with the thighs and tibiæ dark, sometimes almost black; base of coxæ and pulvilli black. Abdomen black, polished and with a very few hairs. Ovipositor sheath protruding. Wings hyaline; veins rather slender and light yellow in color, areolet wanting, cubitus and anal vein almost obsolete and the radial nervure not reaching the costal margin. The anterior wings are without a fringe of hairs upon their borders and the hairs upon the surface of the wings are not well developed but appear in most cases as minute specks.

*Male.* "Antennæ 15-jointed, filiform and longer than the body; parapsidal grooves more distinct than in the female; wings with fringe of hairs and hairs better developed on the surface of the wing. Length, 1.4 mm.; otherwise as the female." (C. P. Gillette).

*Gall.* On the midrib or main veins of a leaf of burr-oak (*Quercus macrocarpa*) in July. A hard woody swelling, the leaf becoming much wrinkled and deformed as the result. Length about 18 mm. Diameter about 6 mm.

*Habitat.* Iowa (Ames).

According to Prof. C. P. Gillette the flies escape from the upper surface

of the leaf through a slightly raised teat-like projection. This species is not known to me but from the description it appears to be referable to the genus *Andricus* or subgenus *Callirhytis*. The types are with Prof. Gillette.

***Neuroterus crassitelus* Provancher.**

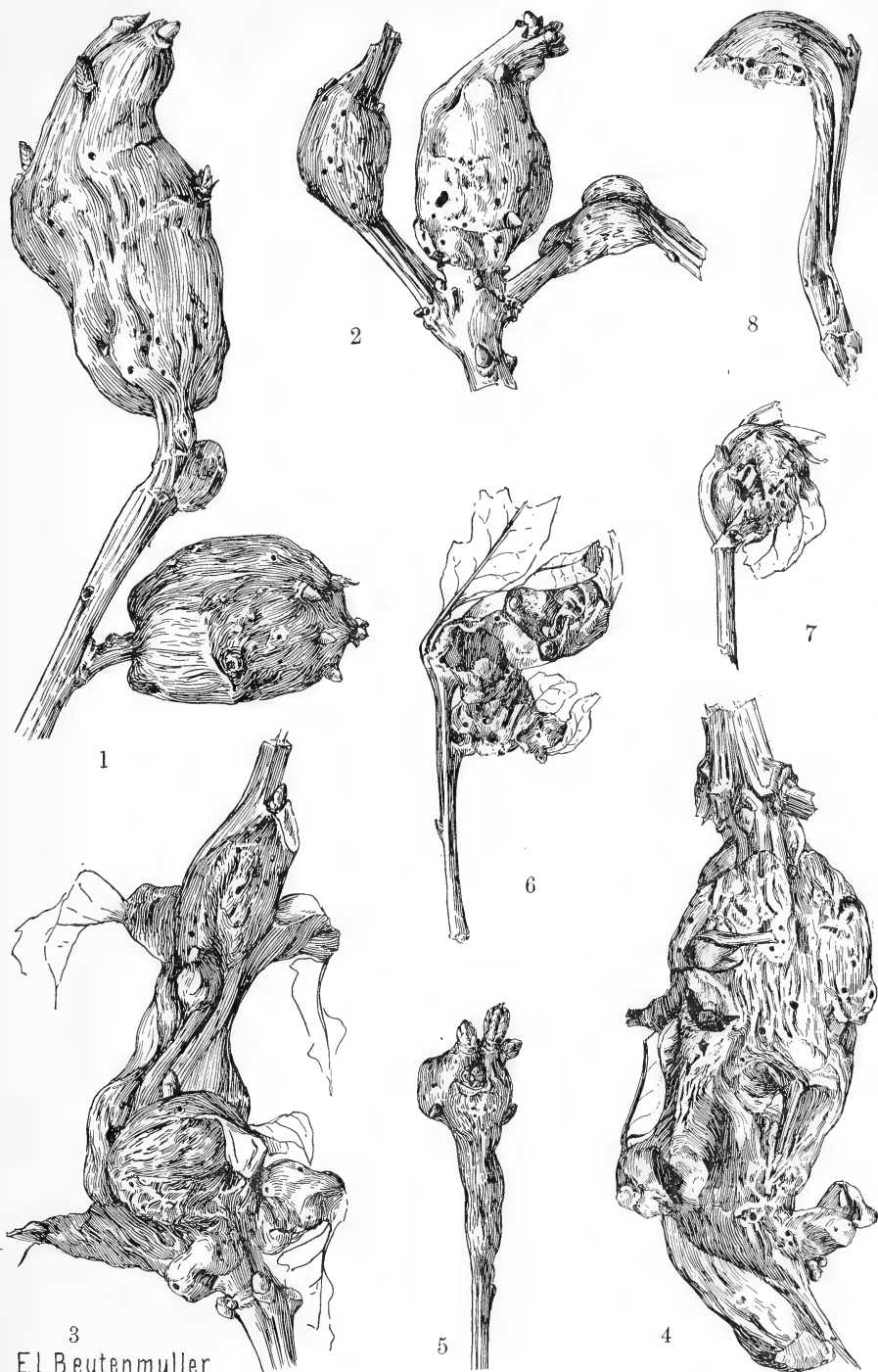
*Cynips (Neuroterus) crassitelus* PROVANCHER, Can. Nat. Vol. XII, 1881, p. 233; Fauna Ent. Can. Hymen., 1883, p. 548.

*Neuroterus crassitelus* ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 296; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 41; DALLA TORRE, and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 50.

*Female.* Reddish brown; a spot on the vertex, extremity of the antennæ, prothorax, metathorax and part of the scutellum, black. Antennæ almost as long as the head and thorax together, second joint very small, third joint long, thickened terminally. Thorax smooth, metathorax rounded, with the sutures of the lobes distinct. Scutellum black at the base and reddish on the summit, an impressed line at base, and without foveæ. Wings hyaline, radial area long and open. Areolet present. Legs reddish brown and the color of the abdomen. Abdomen very compressed, almost semicircular in form, second segment very large, ventral valve clear red, moderately long, its point acute. Ovipositor black, broad, straight and thickening into a club terminally. Length, 2.75 mm.

*Habitat.* Canada.

This species is not known to me; the gall is unknown.

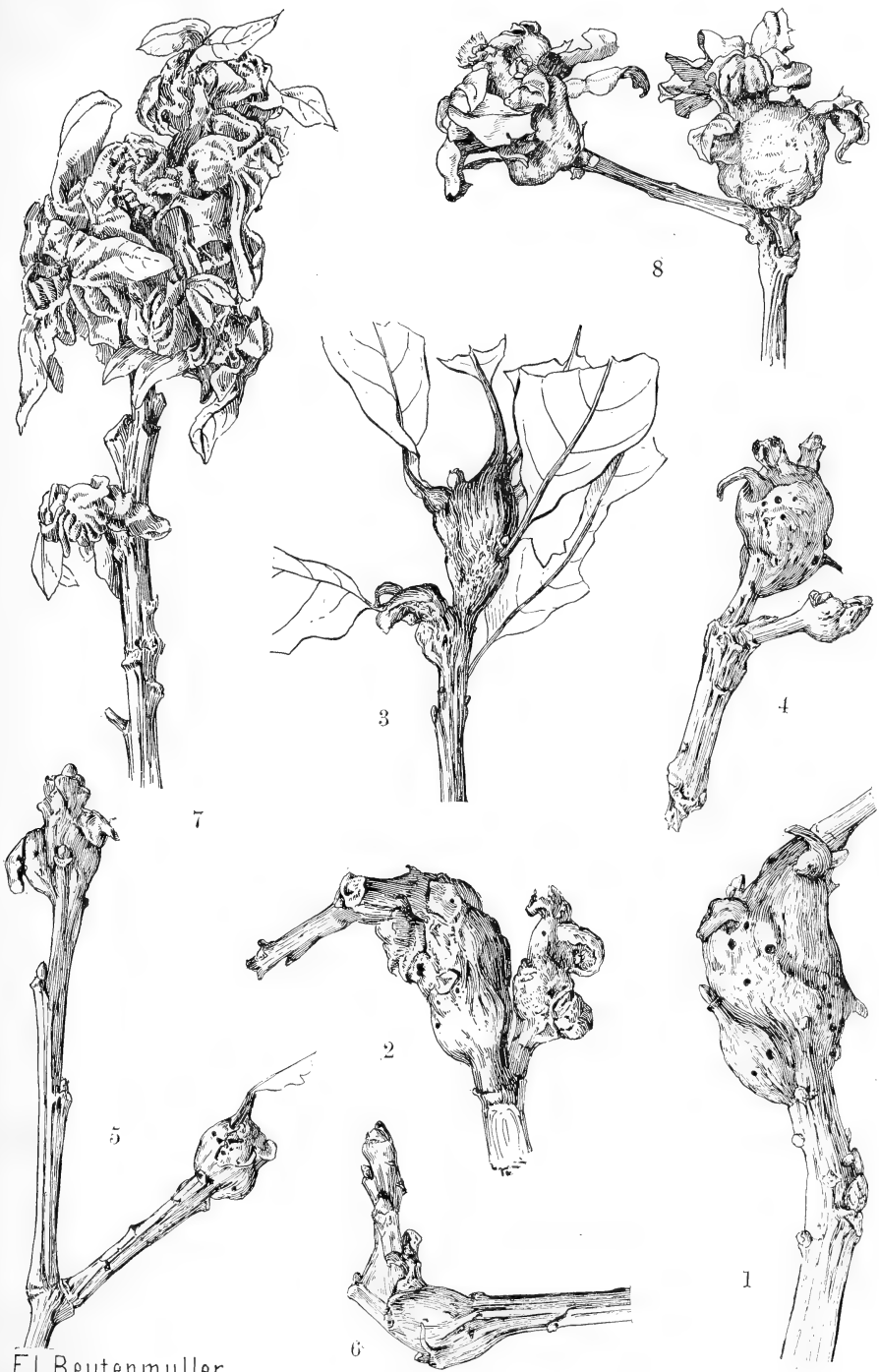


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*Neuroterus batatus* (Fitch).



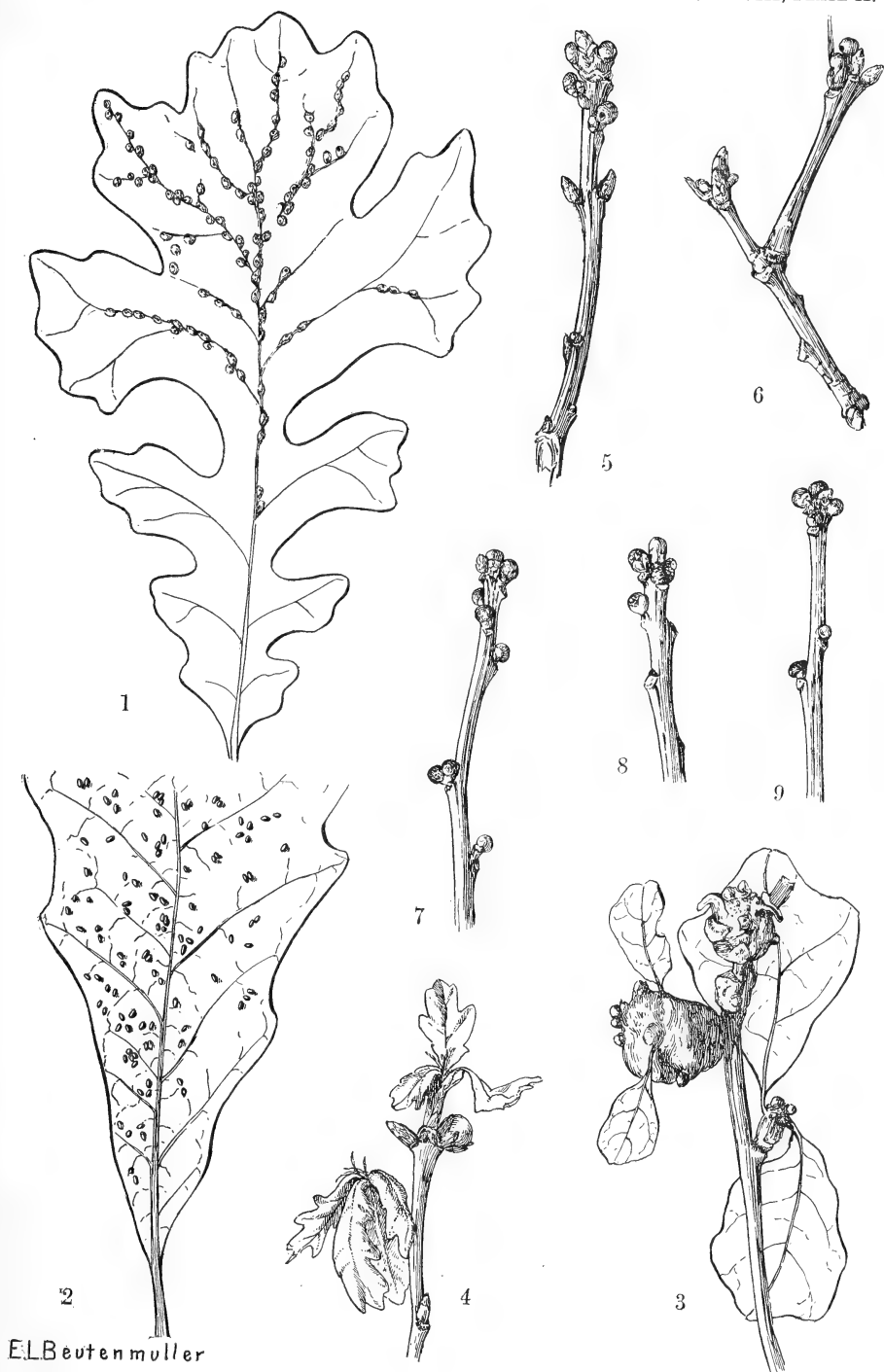




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*Neuroterus noxiosus* (Bassett).

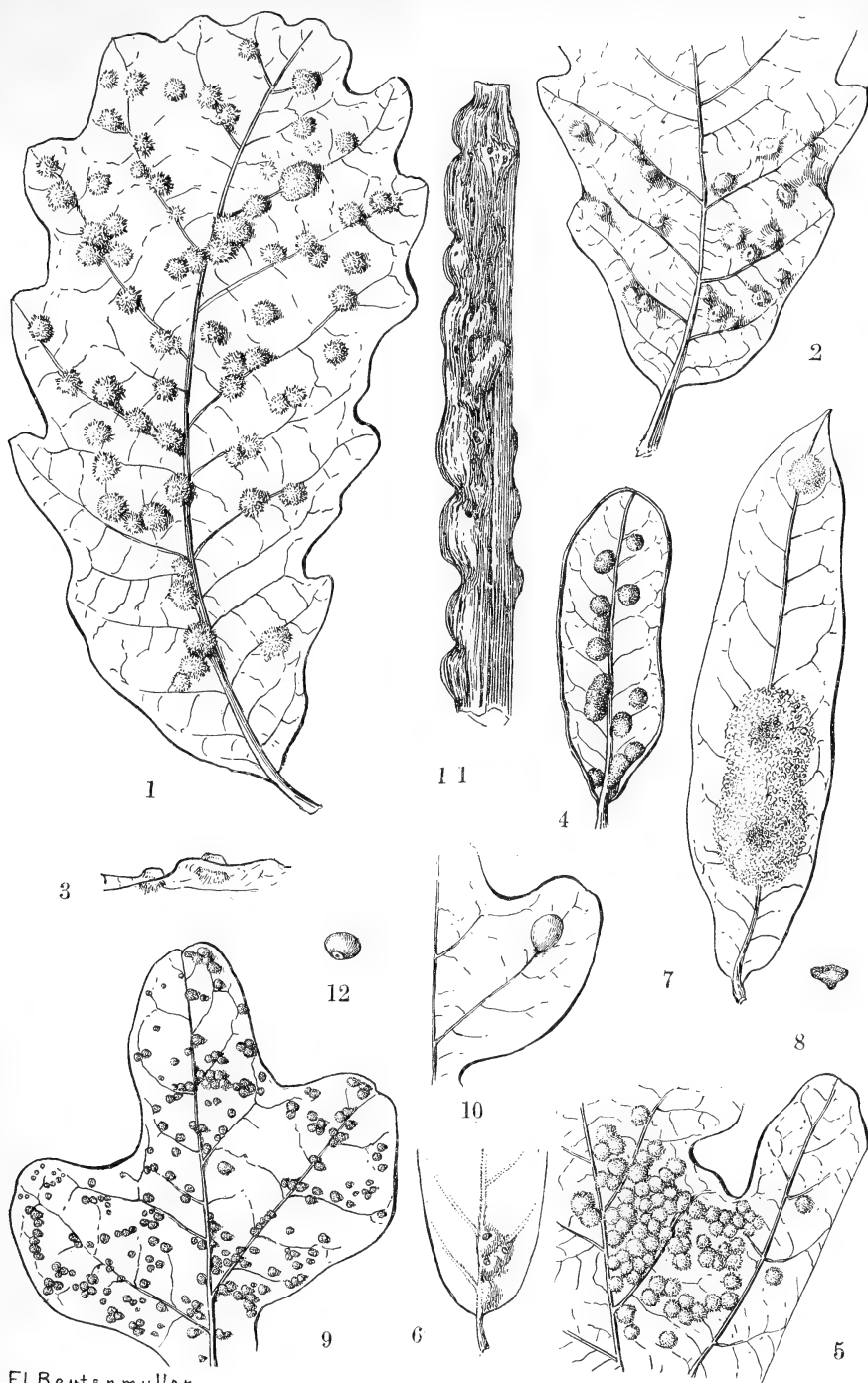




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1. *Neuroterus nigrum* Gillette.
2. " *papillatus* sp. nov.
3. *Neuroterus consimilis* Bassett.
- 4-6. " *vesiculosus* (Bassett).
- 7-9. *Neuroterus affinis* (Bassett).





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- 1-3. *Neuroterus floccosus* (Bassett). Under, upper, and side views.  
 4. *Neuroterus minutissimus* (Ashmead).  
 5. " *verrucarum* (Osten Sacken).  
 6. *Neuroterus howertoni* Bassett.  
 7, 8. " *laurifoliae* Ashmead.  
 9 and 12. " *saltatorius* (Hy. Edwards.).  
 10. " *cockerelli* sp. nov.  
 11. *Neuroterus rileyi* (Bassett).





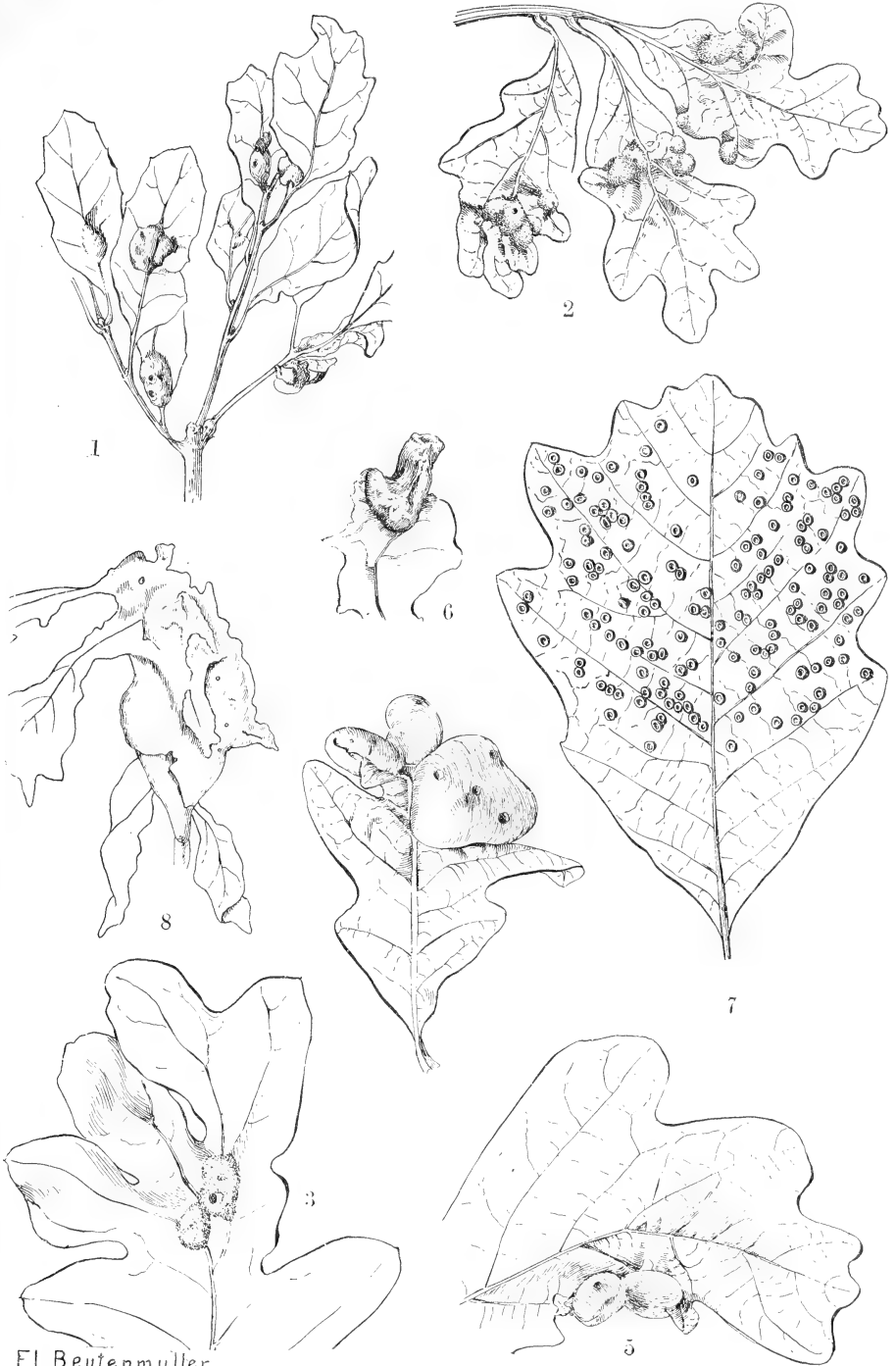
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- 1-2. *Neuroterus tectus* Bassett.  
3-5. " *minutus* (Bassett).  
6. " *distortus* Bassett.  
7. " *pallidus* Bassett.

- 8, 9. *Neuroterus vernus* Gillette.  
10. " *pallipes* Bassett.  
11. " *longipennis* Ashmead.  
12, 13. " *clarkeæ* sp. nov.







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1. *Neuroterus fragilis* Bassett. 4, 6. *Neuroterus majalis* (Bassett).  
2, 3. " *irregularis* (Osten Sacken). 7. " *umbilicatus* Bassett.  
8. *Neuroterus obtusilobæ* (Karsch).



# Article XI.—THE NORTH AMERICAN SPECIES OF *AYLAX* AND THEIR GALLS.

BY WILLIAM BEUTENMÜLLER.

The present paper is the eighth installment of a series of papers on North American Cynipidæ and their galls and treats of the genus *Aylax* Hartig. This name was changed by the same author to *Aulax* without explanations. I have used the term *Aylax* as originally spelled, to conform with the strict rules of nomenclature, as there seems to be no valid reason for changing the name. The genus is allied to *Diastrophus*.

## *Aylax* Hartig.

*Cynips* (in part) LINNÉ, Syst. Nat., Edit. X, 1758, p. 535.

*Diplolepis* (in part) LATREILLE, Hist. Nat. Crust. et Ins., Vol. XIII, 1805, p. 207.

*Aylax* HARTIG, Zeitsch. für Ent., Vol. II, 1840, p. 186; *ibid.*, Vol. III, 1841, p. 334.

*Aulax* HARTIG, Zeitsch. für Ent., Vol. IV, 1843, p. 412; SCHENCK, Jahrb. Ver. Nat. Nassau, Vol. XVII, 1862, p. 170; OSTEN SACKEN, Proc. Ent. Soc. Phila., Vol. II, 1863, p. 34; MAYR, Gen. Gallenb. Cynip., 1881, p. 20; Gen. Europ. Gallenb. Cynip., 1882, p. 6; CRESSON, Synop. Hymen. N. Am., pt. I, 1887, pp. 32, 35; KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 92, DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 73; ASHMEAD, Psyche, Vol. X, 1903, p. 213.

*Isocolus* FÖRSTER, Verh. Zool.-Bot. Ges. Wien, Vol. XIX, 1869, p. 334; Zool. Rec. (1869) 1870, p. 322; MAYR, Gen. Gallenb. Cynip., 1881, p. 20; KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 93; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74; ASHMEAD, Psyche, Vol. X, 1903, p. 213.

*Eubothrus* FÖRSTER, Verh. Zool.-Bot. Wien, Vol. XIX, 1869, p. 336; Zool. Rec. (1869), 1870, p. 323; MAYR, Gen. Gallenb. Cynip., 1881, p. 20; KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 93; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74; ASHMEAD, Psyche, Vol. X, 1903, p. 213.

*Liposthenes* FÖRSTER, Verh. Zool.-Bot. Ges. Wien, Vol. XIX, 1869, p. 336; Zool. Rec. (1869), 1870, p. 323; Gen. Gallenb. Cynip., 1881, p. 21; KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 93; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74; ASHMEAD, Psyche, Vol. X, 1903, p. 213.

*Antistrophus* WALSH, Am. Ent., Vol. II, 1869, p. 74; KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 93; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74; ASHMEAD, Psyche, Vol. X, 1903, p. 214.

*Asclepiadiphila* ASHMEAD, Can. Ent., Vol. XXIX, 1897, p. 74; Psyche, Vol. X, 1903, p. 214; KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 93; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74.

*Gilletia* ASHMEAD, Psyche, Vol. VIII, 1897, p. 69; *ibid.*, Vol. X, 1903, p. 212; KIEFFER, Bull. Soc. Nat. Hist. Metz, ser. 2, Vol. X, 1902, p. 93; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74.

Head large, cheeks broad, sides of face aciculated. Antennæ filiform, 12–14-jointed in the female, 14–15 in the male. Thorax opaque, or semi opaque, with two more or less well defined parapsidal grooves and with the posterior margin truncate. Anterior parallel line, median and lateral grooves present. Scutellum rugose with two large foveæ at the base. Wings hyaline, radial area open at the costa, areolet wanting.

*Type, Cynips rhoecades* Bouche of Europe.

### *Aylax glechomæ* (Linné).

— PANKOW, Herbar. Portat., 1656, p. 709; VELSCH, Scalig. Observ. Hecat., I, 1660, pl. ix, fig. 1; MALPHIGI, Op. Omnia, Vol. I, pt. II, 1686, p. 22, pl. ix, fig. 24; BLANKAART, Schou-Burg, der Ruspen, 1688, p. 186; REAUMUR, Mem. Hist. Insect., Vol. III, 1737, p. 640, pl. xlii, figs. 1–5; LINNÉ, Fauna Suec., 1746, p. 949; Wästgöta Resa, 1747, p. 107.

*Cynips glechomæ* LINNÉ, Syst. Nat. ed. X, 1758, p. 553; *ibid.*, ed. 12, 1767, p. 917; Fauna Suec., ed. 2, 1761, p. 386; BRÜNNICH, Prod. Insect. Siaelland, 1761, p. 16; SCOPOLI, Entom. Carn., 1763, p. 273; MÜLLER, Fauna. Insect. Fridrichdal, 1764, p. 67; Zool. Dan. Prodr., 1776, p. 147; FABRICIUS, Syst. Ent., 1775, p. 315; Spec. Insect., Vol. I, 1781, p. 403; Mant. Insect., Vol. I, 1787, p. 252; Entom. System., Vol. II, 1793, p. 101; Syst. Piez., 1804, p. 143; BERKENHOUT, Outlin. Nat. Hist. Gr. Brit., Vol. I, 1769, p. 162; FOURCROY, Entom. Paris, Vol. II, 1785, p. 386; VILLERS, Linnæi Entom., Vol. III, 1789, p. 70; GMELIN, Linné, Syst. Nat., ed. 13, 1790, p. 2649; OLIVIER, Encycl. Method. Insect., Vol. V, 1790, p. 788; CHRIST, Naturg. der Insect., 1791, p. 480, pl. 57, fig. 2; FISCHER, Vers. Naturg. Lievland, Ed. II, 1791, p. 341; CEDERHJELM, Faun. Ingric. Prodr., 1798, p. 143; SCHRANK, Fauna Boica, Vol. II, 1802, p. 219; SCHRÖKENSTEIN, Verz. d. Halbkäfer, 1802, p. 19; WALCKENAER, Fauna Paris, Vol. II, 1802, p. 26; JURINE, Nouv. Meth. Class. Hymen., 1807, p. 286; INCHBALD, Ent. Weekly Intell., Vol. X, 1861, p. 171 (adult and gall).

*Diptolepis glechomæ* LATREILLE, Hist. Nat. Crust and Insect., Vol. XIII, 1805, p. 207; LAMARCK, Hist. Nat. Animal. sans Vert., Vol. IV, 1817, p. 163; *ibid.*, ed. 2, Vol. IV, 1835, p. 372 (galls only); DUMÉRIL, Mem. Acad. Sci. Paris, Vol. XXXI, 1860, p. 965 (adult).

*Aylax glechomæ* HARTIG, Zeitsch. für Ent., Vol. III, 1841, p. 342; KALTENBACH, Ver. Natur. Preuss. Rheinl., Vol. XIX, 1862, p. 22; Pflanzenf., 1874, p. 488; MACLACHLAN, Trans. Ent. Soc. Lond., Vol. V, Ser. 3, 1866, p. ix; WEYENBERGH, Tijdschr. Entom., Vol. XVII, 1874, p. 167.

*Aulax glechomæ* HARTIG, Zeitsch. für Ent., Vol. IV, 1843, p. 412; TASCHENBERG, Hymen. Deutschl., 1866, p. 132; THOMPSON, Opusc. Entom., 1877, p. 809; MAYR, Europ. Gallenb. Cynip., 1882, p. 7; Verh. Zool.-Bot. Gesell. Wien, Vol. VII, 1902, p. 287; CAMERON, Ent. Month. Mag., Vol. I, ser. 2, 1890, p. 314; HIERONYMUS, Ergänzungsheft. Schles. Gesell., 1890, p. 194; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 120; KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 94.

*Diastrophus glechomæ* SCHENCK, Jahrb. ver. Natur. Nassau, Vol. XVII–XVIII, 1862–63, pp. 211, 212, 248; RUDOW, Arch. Ver. Fr. Natur. Mecklenburg, Vol. XXIX, 1875, pp. 43, 63; MAYR, 15 Jahrb. Comm. Oberrealsch. Wien, 1876, p. 7.

*Aulax glechomatis* MARSHALL, Ent. Month. Mag., Vol. IV, 1868, p. 274; MÜLLER, Entom. Annual, 1872, p. 10.

*Liposthenes glechomæ* FÖRSTER, Verh. Zool.-Bot. Gesell. Wien, Vol. XIX, 1869, p. 336.

*Liposthenes glechomatis* MARSHALL, Entom. Annual, 1874, p. 117.

*Diastrophus similis* BASSETT, Can. Ent., Vol. XIII, 1881, p. 95; ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 294; *ibid.*, Vol. XIV, 1887, p. 134; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 109; MAYR, Verh. Zool.-Bot. Gesell. Wien, Vol. LII, 1902, p. 287; COOK, Ohio Nat., Vol. III, 1903, p. 428, figs. 66-69; *ibid.*, Vol. IV, 1904, pp. 119, 120, 126, figs. 86, 106 a. b.

*Aulax similis* DALLA TORRE and KIEFFER, Gen. Insect. Hymen. Fam. Cynip., 1902, p. 75.

*Female*. Head black, finely rugoso-punctate on the vertex and posteriorly, face roughly and distinctly aciculate, median ridge rugoso-punctate. Antennæ 13-jointed, rufous. Collar black, aciculate with a patch of dull golden yellow hairs laterally. Thorax black, somewhat shining but not polished, evenly reticulately punctate. Parapsidal grooves broad, deep, very distinct and narrowly converging at the scutellum. Median line at scutellum very short. Anterior parallel lines rather long, shining and distinct. Lateral grooves long and distinct. Pleuræ aciculate. Scutellum black, rugose, foveæ at base large, deep and shining. Abdomen black or piceous, shining. Legs rufous, claws black. Wings hyaline, veins yellowish brown. Cubitus not reaching the first cross-vein. Radial area open. Areolet wanting. Length, 2.5-3 mm.

*Gall*. (Plate XIV, Figs. 1, 2, 3.) On the petioles, leaves and sometimes on the stems of ground ivy (*Glechoma hederacea*). Monothalamous when simple, polythalamous when compound. The simple galls are round, green, and covered with short hairs. When compound they are very irregular in form and size and have two or more larval cells, which are held in position by coarse fibres. When dry and old the galls are brown, with a thin paper-like outer covering, which sometimes disappears when lying on the ground through the winter and the bleached fibres surrounding the larval cells look like little burrs. Diameter, 6-25 mm.

*Habitat*. Europe; Massachusetts; New York; New Jersey; Connecticut; Ohio; Illinois.

### ***Aylax leavenworthi* (Bassett).**

*Antistrophus leavenworthi* BASSETT, Trans. Am. Ent. Soc., Vol. XXVI, 1900, p. 310.

*Aulax leavenworthi* KIEFFER, Bull. Soc. Hist. Nat. Metz., ser. 2, Vol. X, 1902, p. 94; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74.

*Antistrophus silphii* GILLETTE, Bull. Ill. St. Lab. Nat. Hist., Vol. III, 1891, p. 192, pl. ix, fig. 1 and 2; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 107.

*Aulax silphii* KIEFFER, Bull. Soc. Hist. Nat., Vol. X, ser. 2, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, 74; MAYR, Verh. Zool.-Bot. Gesell. Wien, LII, 1902, p. 288.

*Female*. Head black, opaque, very minutely and densely striate, median ridge somewhat flattened, mandibles rufous, vertex and cheeks densely sculptured, in form of microscopic pits. Antennæ 14-jointed, dark rufous, first two joints darker. Thorax black opaque, very finely and densely punctured. Parapsidal grooves distinct. Median groove broad at the scutellum and traceable to the collar. Lateral grooves distinct. Anterior parallel lines rather long. Pleuræ opaque, finely punc-

tate. Scutellum black, rugoso-punctate, foveæ large and deep, somewhat shining. Legs: anterior pairs dark rufous, middle and hind pair very dark pitchy brown. Abdomen pitchy black polished. Wings hyaline, veins delicate and rather faint, radial area open. Areolet wanting. Length, 3-4 mm.

*Male.* Differs from the female by being smaller and the antennæ 15-jointed. Length, 2.75-3 mm.

*Gall.* (Plate XIV, Figs. 4, 5.) On the tips of the stems of rosin-weeds (*Silphium integrifolium* and *Silphium perfoliatum*). Polythalamous. Abrupt, subglobular, tumor-like swellings, usually stunted with aborted growths of leaves and stems. Green when fresh, dark brown and woody when dry. Internally (fig. 5) it is composed of white pith in which are many larval cells. Length, 30-75 mm.

*Habitat.* Illinois (Champaign and Normal); Virginia (Petersburg); Mts. of Georgia (Macon Co.).

The types of *A. leavenworthi* and *A. silphii* are before me and I cannot find any differences between the two. The gall on Plate XIV was made from one of Prof. Gillette's types of *A. silphii*. The type of *A. leavenworthi* is in the collection of the American Entomological Society and the gall is in poor condition.

### ***Aylax laciniatus* (Gillette).**

*Antistrophus laciniatus* GILLETTE, Bull. St. Lab. Nat. Hist., Vol. III, 1891, p. 194, pl. ix, fig. 3; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 106.

*Aulax laciniatus* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 94. DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74.

*Female.* Head black, opaque, face rather coarsely aciculate, median ridge with a few coarse punctures or pits, vertex and sides densely sculptured, vertex with a broad furrow extending up from the antennæ. Mandibles rufous on the median portion. Antennæ 13-jointed, black. Thorax black, opaque, finely and deeply sculptured. Parapsidal grooves distinct. Median groove continuous from the scutellum to the collar. Lateral grooves distinct. Anterior parallel line short and somewhat shining. Scutellum coarsely wrinkled, bifoveolate. Abdomen rufopiceous, polished, globose. Legs including the coxæ black, tip of femora, tarsi and anterior tibiæ rufous. Wings hyaline, veins faint. Areolet wanting. Length, 3 mm.

*Male.* Like the female, except with the abdomen black and 14-jointed antennæ. Length, 2 mm.

*Gall.* (Plate XIV, Fig. 6.) In clusters on the receptacles of the flowers of rosin weed (*Silphium laciniatum*). Individual galls are egg-shaped and from 4 to 5 mm. in length.

*Habitat.* Illinois (Champaign).

According to Mr. C. A. Hart the galls occur in well-ripened, healthy looking flower heads, but do not show until the weather has removed the uninfested flowerlets. They are always produced in the sterile flowers of the disk, toward the center.

The types are in the Illinois State Laboratory of Natural History and a pair was sent to me for study by Mr. Hart. The species is closely allied to *A. leavenworthi*. The figure of the gall on Plate XIV is a copy of Gillette's illustration, and is much enlarged.

***Aylax rufus* (Gillette).**

*Antistrophus rufus* GILLETTE, Bull. St. Lab. Nat. Hist., Vol. III, 1891, p. 195; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 107.

*Aulax rufus* MAYR, Verh. Zool.-Bot. Gesell. Wien, Vol. LII, 1902, p. 288; KIEFFER, Bull. Soc. Hist. Metz, ser. 2, Vol. X, 1902, p. 95; DALLA TORRE, Gen. Ins. Hymen. Cynip., 1902, p. 74.

*Female*. Head rufous, vertex black or blackish, very finely and minutely punctate. Antennæ 13-jointed, rufous. Thorax black, very finely and densely punctate. Parapsidal groove fine and distinct. Median groove not quite reaching the two very short anterior parallel lines. Lateral grooves distinct. Pleuræ and sides of collar rufous. Scutellum very finely sculptured with two large, broad, shallow foveæ at the base. Abdomen rufous, somewhat darker dorsally. Legs entirely rufous. Wings hyaline, veins faint and delicate. Areolet wanting. Length, 2.50–3 mm.

*Male*. Similar to the female but with 14-jointed antennæ. Length, 2–2.20 mm.

*Gall*. (Plate XIV, Fig. 7.) In the stems of rosin weeds (*Silphium laciniatum*, *Silphium perfoliatum*, *Silphium integrifolium* and *Silphium terebinthinaceum*). There is not the slightest indication of a swelling upon the outer part of the stem and the larvæ live in small oval cells in the pith of the plants.

*Habitat*. Illinois.

Two type specimens were sent to me by Mr. C. A. Hart. They are in the Illinois State Laboratory of Natural History. The figure of the gall on Plate XIV was made from one of Prof. Gillette's types.

***Aylax gillettei* Kieffer.**

*Antistrophus minor* GILLETTE, Bull. Ill. St. Lab. Nat. Hist., Vol. III, 1891, p. 196; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 106.

*Aulax gillettei* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74.

*Male and female*. Allied to *A. rufus*, but the collar is deeper rufous. The parapsidal and median grooves do not appear as sharply defined furrows, but only as broad slightly depressed lines with sloping sides. The foveæ of the scutellum are rather deep at the base, extend far back and are not separated by a sharply defined septum, but by a broad slightly elevated ridge. The scutellum is also longer in proportion to its breadth and is perceptibly narrowed at the sides, about midway of the length. Length of male, 1.50 mm.; of female, 2 mm.

*Gall*. Same as in *A. rufus*.

This species was bred by Prof. C. P. Gillette from the same stems of

*Silphium* containing *A. rufus*. Two types of *minor* are before me and I regard this species to be nothing more than small specimens of *A. rufus* with ill-defined parapsidal and median grooves. The types are in the Illinois State Laboratory of Natural History. The name *A. minor* is pre-occupied by a European species.

### *Aylax pisum* (Walsh).

*Antistrophus pisum* WALSH, Am. Ent., Vol. II, 1870, pp. 73, 74, fig.; ASHMEAD, Trans. Am. Ent. Soc., Vol. XII, 1885, p. 294; *ibid.*, Vol. XIV, 1887, p. 134; GILLETTE, Ent. News, Vol. III, 1892, p. 247; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 106.

*Aulax pisum* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74.

*Asclepiadiphila stephanotidis* ASHMEAD, Can. Ent., Vol. XXIX, 1897, p. 263.

*Aulax stephanotidis* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 75.

*Female*. Head varying from rufous to almost black, vertex usually black, confluent and almost microscopically punctate. Antennæ 13-jointed, terminal joints rufous, sometimes darker. Thorax rufous, sometimes marked with black or almost wholly brown black, opaque, very finely and confluent punctate. Parapsidal grooves fine, but distinct, rather widely separated at the scutellum. Median groove not quite extending forward to the end of the anterior parallel lines which are smooth and shining. Lateral grooves present. Scutellum rufous or blackish brown, rugoso-punctate, foveæ large, broad and almost confluent, and only faintly separated by a fine ridge. Abdomen dark brown, polished. Legs rufous. Wings hyaline, veins delicate. Radial area closed; cubitus very faint and delicate. Areolet wanting. Length, 2.75–3.50 mm.

*Male*. Darker than the female. Head and thorax very dark rufous or brown, abdomen almost black. Antennæ 14-jointed. Legs very dark brown, joints sometimes paler. Length, 2–2.75 mm.

*Gall*. (Plate XIV, Fig. 10.) On the stems of *Lygodesma juncea*. Monothalamous. Round or oval, pea-like, containing a central cavity. It is soft, pithy and internally consists of a dense whitish spongy substance which ultimately becomes quite hard and compact. Diameter, 5–12 mm.

*Habitat*. Nebraska; Missouri; South Dakota; Oregon.

I have examined the types of the flies and galls of *Asclepiadiphila stephanotidis* in the United States National Museum, and I cannot find any differences between these and those of *Antistrophus pisum*, neither specifically nor generically. The galls of *stephanotidis* are from Oregon and Missouri and are said to be found on a species of *Stephanotis*.

### *Aylax taraxaci* (Ashmead).

*Gillettea taraxaci* ASHMEAD, Psyche, Vol. VIII, 1897, p. 69.

*Aulax taraxaci* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 75.



*Female*. Head black, face subopaque, shagreened; top of head feebly and microscopically shagreened. Mandibles pale rufous with black teeth, bidentate. Antennæ 14-jointed, nearly as long as the body, brown black with tip of pedicel and first joint of flagellum honey yellow. Mesothorax polished with the disk microscopically shagreened. Sides subopaque and more distinctly shagreened. Parapsidal grooves distinct, parallel and widely separated. Median groove vaguely defined. Anterior parallel lines short, and only visible in certain lights. Scutellum smooth or nearly so, with two narrow, oblique foveæ at the base. Abdomen black, polished. Legs: coxæ black, femora brown black, toward the apex as well as all the tibiæ and tarsi, honey yellow, the tibiæ at the middle and the two or three terminal joints of the tarsi obfuscated. Wings hyaline, veins blackish, radial area open. Areolet distinct, small, triangular. Length, 1.50 mm.

*Male*. Similar to the female. The antennæ are slightly longer, the third joint honey yellow only at the base. All the femora, except the anterior tips, black. Marginal and costal cells more or less confluent. Length, 1.10 mm.

*Gall*. (Plate XIV, Fig. 8.) Along and surrounding the petiole or midrib of the leaf of the common dandelion (*Taraxacum taraxacum*). Polythalamous. Pithy, irregular, oblong swellings, usually composed of knotty swellings and occurring together and forming, oblong irregular galls. Length 25–50 mm.

*Habitat*. Minnesota (Winona); New York; Canada (Ontario).

### ***Aylax chrysothamni* Beutenmüller.**

*Aylax chrysothamni* BEUTENMÜLLER, Journ. N. Y. Ent. Soc., Vol. XVI, 1908, p. 45, pl. ii.

*Male and female*. Head rufous, vertex piceous in the female, wholly black in the male, very finely and minutely punctate, opaque. Antennæ 14-jointed in the female, rufous; 15-jointed in the male, black. Thorax black in both sexes, very minutely and evenly punctate, subopaque. Parapsidal grooves obliterated anteriorly, very fine posteriorly and convergent at the scutellum. Anterior parallel lines very indistinct and scarcely reaching the middle of the thorax. Median groove wanting. Lateral grooves somewhat distinct. Pleuræ finely striate. Scutellum black, rugose with two pit-like foveæ at the base. Abdomen black in both sexes. Legs rufous. Wings hyaline, veins distinct, brown, radial area open. Areolet wanting. Length of male, 1.50 mm.; of the female, 2.50 mm.

*Gall*. (Plate XIV, Fig. 9.) On the stems, usually at the tips, of a species of *Chrysothamnus* (*Bigelovia*). Polythalamous. White and densely covered with a white felt-like pubescence. Elongate, rounded or club-shaped, enlargements of the twigs. White and pithy inside with many scattered larval cells. Sometimes two or three galls are in a row on the same branch. Length, 15–30 mm. Diameter 12–20 mm.

*Habitat*. Arizona (Tucson).

### ***Aylax bicolor* (Gillette).**

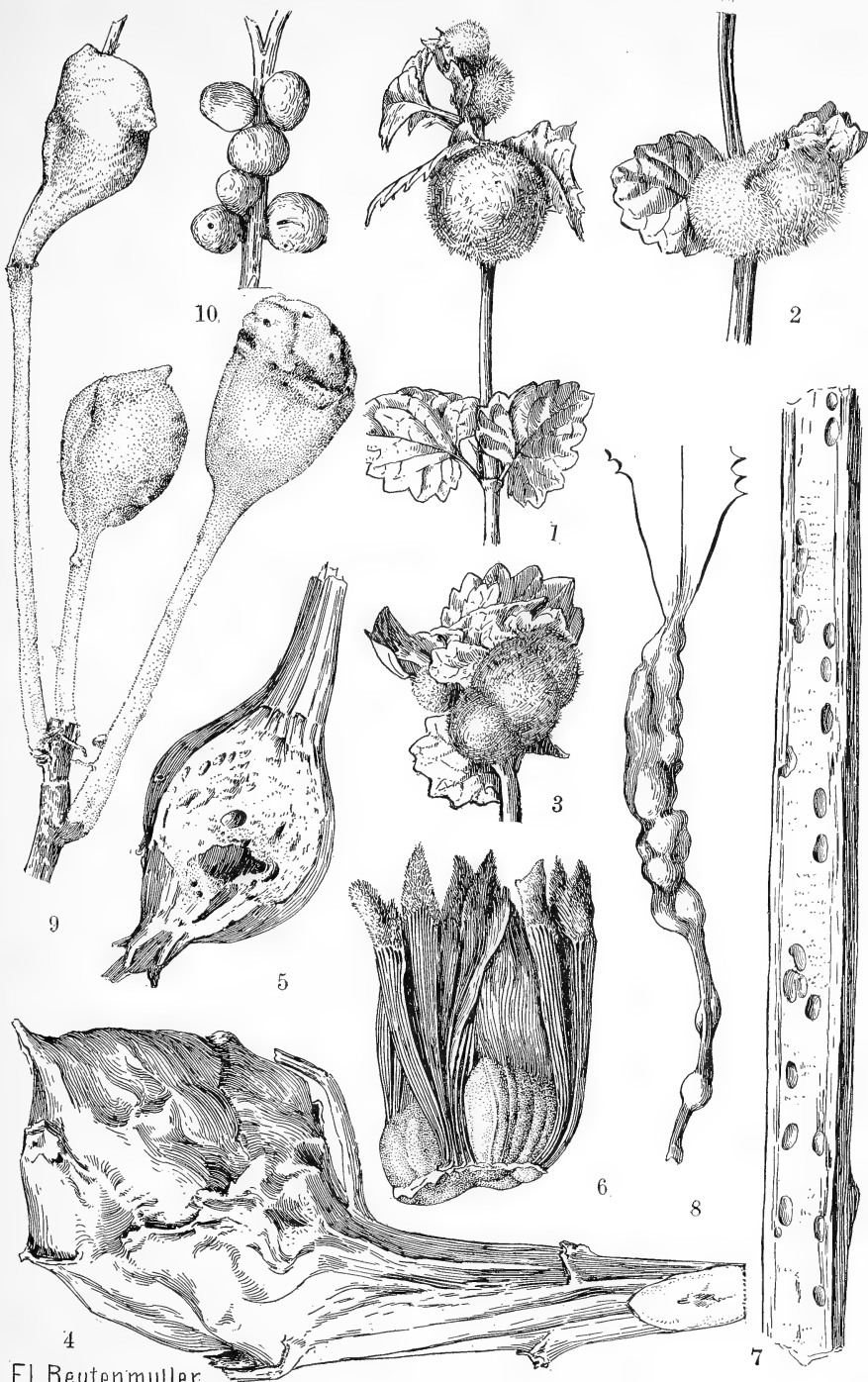
*Antistrophus bicolor* GILLETTE, Bull. Ill. St. Lab. Nat. Hist., Vol. III, 1891, p. 197; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 106.

*Aylax bicolor* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 94; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 74.

*Female.* Head black, finely and densely sculptured, mandibles except tips rufous, face between eyes and mouth coarsely aciculate, frontal ridge rather prominent, ocelli in nearly a straight line. Antennæ dark rufous, 13-jointed, third and fourth joints equal in length, 13th joint about as long as the two preceding together. Thorax, including pleuræ, densely and finely sculptured. Parapsidal and median grooves distinct and extending to the collar. Lateral grooves and anterior parallel lines plainly marked. Scutellum sculptured like the mesothorax, foveæ at base scarcely separated, and appearing as a deep transverse groove. Abdomen rufous, polished, second segment occupying a little more than one third of the dorsum; third segment very broad, and microscopically punctured on the apical portion; succeeding segments to the seventh all exposed and rather densely punctured as seen under a high power lens; venter rather prominent, and ovipositor sheath projecting slightly. Feet: the tarsi, tibiæ of front pair, and joints of all the legs more or less rufous, the remaining portions black. Wings hyaline, radial cell open, all the veins except the two transverse, very weak. Areolet entirely wanting. Length, 3 mm.

*Habitat.* Illinois (normal).

The type of this species was sent to me for examination by Mr. C. A. Hart. In general appearance and color it is like *Aulacidea bicolor*, but the parapsidal grooves are different, the radial area is open at the costa, and the cubitus almost reaches the first cross-vein. The gall is not known.



EL Beutenmüller

1-3. *Aylax glechomæ* (Linné).4, 5. " *leavenworthi* (Bassett).6. " *laciniatus* (Gillette).7. *Aylax rufus* (Gillette).8. *Aylax taraxaci* (Ashmead).9. " *chrysothamni* Beutenmüller.10. *Aylax pisum* (Walsh).



**Article XII.**—MAMMALS FROM THE CAURA DISTRICT OF VENEZUELA, WITH DESCRIPTION OF A NEW SPECIES OF *CHROTOPTERUS*.

By J. A. ALLEN.

A short time since a small but interesting collection of mammals was received from the Caura region of Venezuela, collected for the Museum by Mr. M. A. Carriker, Jr., during November and December, 1909. The 26 specimens contained in the collection represent 14 species, of which one proved to be new. All of the larger species are represented by one or more complete skeletons.

The Museum had previously received, in 1900–1902, a considerable collection of mammals from the vicinity of Ciudad Bolivar and the Lower Caura collected by Mr. Samuel M. Klages, reported upon by me in Volume XX of this Bulletin.<sup>1</sup> Most of the species in the Carriker collection are represented in the Klages collection, but from very different localities. Mr. Carriker's collection was made on the Rio Mato, the largest western tributary of the Rio Caura, and on the Rio Mocho, a tributary of the Rio Mato.

The monkeys here recorded have been kindly determined by Dr. D. G. Elliot, who is now monographing the Primates.

1. *Bradypus tridactylus flaccidus* (Gray).

One specimen, a very young female apparently in first pelage (total length 260 mm.), Rio Mato, Nov. 3.

The body pelage is dull drab, with the rump whitish, varied elsewhere with small patches of white; face and throat white with a faint tinge of fulvous; narrow black eye-stripes. The hair of the facial region is entirely different in structure from that of the body, being fine and bristly. Although so young, the dentition is fully developed, except that the teeth are small.

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<sup>1</sup>New Mammals from Venezuela and Columbia. Bull. Amer. Mus. Nat. Hist., Vol. XX, 1904, pp. 327–335, Oct. 8, 1904.

List of Mammals from Venezuela, collected by Mr. Samuel M. Klages. *Ibid.*, pp. 337–345, Oct. 8, 1904. Annotated list of 46 species.

2. **Tamandua longicaudata** (*Wagner*).

One specimen, adult female, Maripa, Dec. 21, in the usual straw-colored pelage.

"Total length, 1070<sup>1</sup>; tail, 505; hind foot, 90." Skull, total length, 133; occipito-nasal length, 127; greatest width of braincase, 42.

3. **Proechimys cherriei** (*Thomas*).

Two specimens, adult females, Rio Mocho, Nov. 26.

4. **Sciurus flammifer** *Thomas*.

One specimen, adult male, Rio Mocho, Nov. 24.

5. **Sciurus æstuans gilvularis** (*Wagner*).

One specimen, adult female, Rio Mocho, Dec. 4.

6. **Pteronura brasiliensis** (*Zimmermann*).

Two specimens, male and female, both old, Rio Mocho, Dec. 8 and 10. Skin and complete skeleton of each.

The collector's measurements and notes are as follows:

No. 30190, ♂, total length, 1595; tail, 575; hind foot, 195; circumference of neck just behind ear, 375; circumference of chest, 540; circumference of tail at base, 250. Soles of feet black, lips flesh color.

No. 30191, ♀, total length, 1530; tail, 530, hind foot, 174; circumference of neck just behind ears, 380; circumference of chest, 550; circumference of tail at base, 260. Soles of feet black, lips flesh color.

Skulls, condylobasal length, ♂ 152, ♀ 157; zygomatic breadth, ♂ 95, ♀ 91.

The female has the whole throat and foreneck, from the lips to the breast, pale yellowish white; in the male the chin and upper throat are white, the foreneck broadly and irregularly streaked with white.

7. **Tayra barbara barbara** (*Linnaeus*).

One specimen, adult female, Rio Mocho, Nov. 29. "Iris brown, nose and soles of feet black."

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<sup>1</sup> Measurements are in millimeters.

The collector's measurements are, total length, 960; tail 390; hind foot, 105. The specimen is glossy black, with the head and neck gray in strong contrast; the throat-spot is large, V-shaped, and deep yellow.

8. *Nasua phaeocephala* Allen.

One specimen, adult female, Rio Mocho, Nov. 24. "Iris brown; nose and soles black."

Collector's measurements, total length, 943; tail, 405; hind foot, 90. Skull, total length, 120; condylobasal length, 111; zygomatic breadth, 59.

This specimen agrees closely in all respects with the type, from Suapure, Venezuela.

9. *Peropteryx kappleri* Peters.

Two specimens, Rio Mocho, Nov. 29.

10. *Chrotopterus carrikeri* sp. nov.

Type, No. 30181, ♂ ad., Rio Mocho, Venezuela, Dec. 6, 1909; collected by M. A. Carriker, Jr., for whom the species is named.

Above dark seal brown, the basal portion of the hairs buff, the extreme tips whitish, giving an almost imperceptible grayish wash to the surface (nearly absent in some specimens); nose, chin, and a broad band passing below the base of the ears blackish brown; throat, breast, and middle of abdomen pure white; sides and anal region grayish brown, restricting the white to the median ventral area; membranes very dark brown or black; ears lighter brown with an extremely narrow whitish margin; under side of fore-arm flesh-color, the proximal third and the humerus covered with short grayish brown hairs, which extend also on to the immediately adjacent membrane, where they are longer and whitish; under surface of hind limbs flesh-color and naked; membranes naked, except as above stated; nose-leaf blackish brown, V-shaped, broad at base and acutely pointed. Tail short, situated close to the base of the interfemoral membrane, not easily recognized in the dry skin.

External measurements (type): "Length, 90 mm.; tail, 9; expanse, 356." Fore-arm, 47 thumb (s. u.), 15; 3d metacarpal, 39; 4th, 41; 5th, 47; tibia, 23; hind foot, 15; calcar, 18; ear from head, 19, from notch, 24; tragus, 7.5; nose-leaf (dry), about 5 mm. high by 5 wide at base.

Skull, greatest length, 26; condylobasal length, 21; basilar length, 18; palatal length, 9.5; zygomatic breadth, 12; postorbital constriction, 4; breadth at canines, 4.8; mastoid breadth, 12.8; depth of cranium from sagittal ridge to basi-sphenoid, 11.5; depth of crest, 3; length of upper toothrow (including canine), 9; greatest length of mandible, 16; depth from coronoid process to angle, 7; length of lower toothrow, 10.

The type is a very fully matured male, with the sagittal crest highly developed; in young males and females the crest is absent or only slightly developed, and the measurements both external and cranial are less.

Represented by 7 specimens (skins and skulls), 2 males and 5 females, all taken on the same day and at the same locality. There is practically no variation in color, except that the younger specimens have the dorsal surface darker than the old male type described above.

The collector's external measurements of the series are as follows:

No. 30181, ♂, total length 90; tail, 9; expanse, 356.
" 30178, ♂, " " 80; " 13; " 332.
" 30180, ♀, " " 99; " 9; " 343.
" 30179, ♀, " " 85; " 14; " 346.
" 30182, ♀, " " 82; " 11; " 336.
" 30183, ♀, " " 81; " 13; " 351.
" 30177, ♀, " " 80; " 12; " 342.

*Chrotopterus carrikeri* is much smaller than *C. auritus*, and very differently colored, but in general structure and proportions, absence of fur on the membranes, the striations on the outer half of the ear, and in the characters of the skull and teeth it agrees in all essential details with that species. The pure white underparts, however, render it a striking species, almost unique in Phyllostome bats.

#### 11. *Molossus obscurus* Geoffroy.

One specimen, Rio Caura, Venezuela, Oct. 15.

#### 12. *Alouatta macconnelli* Elliot.

Two specimens, males, one old, the other a young adult, Rio Mato, Nov. 3.

No. 30193, ♂, total length, 1240, tail, 650; hind foot, 162. "Skin of face all black; feet and tail black; iris brown."

No. 30194, ♂, total length, 1180; tail, 657; hind foot, 156. "Iris brown, face, feet and tail black."

Skulls: Total length, old ♂, 132, ♂ juv., 103; zygomatic breadth, old ♂, 82, ♂ juv., 71.

#### 13. *Ateles variegatus* Humboldt.

*Ateles belzebuth* ALLEN (not of I. Geoffroy), Bull. Amer. Mus. Nat. Hist., XX, 1904, p. 344.

One specimen, adult male, Rio Mato, Oct. 30.

"Length, 1930; tail, 930; hind foot, 198. Soles of feet and face black, except lips and spot over eye whitish; iris hazel."

Skull, ♂, total length, 162; mastoid breadth, 75.



14. *Cebus apiculatus* Elliot.

*Cebus fatuellus* ALLEN, Bull. Amer. Mus. Nat. Hist., XX, 1904, p. 344.

Six specimens — 3 skins with skulls, 1 skin with skeleton, and 1 additional skeleton: Maripa, Rio Caura, 3 adult males, Oct. 9 and 15; Rio Mocho, 2 males and a female, Nov. 14, 23, and Dec. 8.

The collector's measurements and notes are:

No. 30197, ♂, total length, 950; tail, 480; hind foot, 135, Maripa.	
" 30195, ♂, " " 960; " 490; " " — "	
" 30199, ♂, " " 935; " 500; " " 130, Rio Mocho.	
" 30198, ♂, " " 858; " 455; " " — " "	
" 30196, ♀, " " 865; " 480; " " 123, " "	

No. 30198, ♂ juv., "iris hazel; face nearly entirely white, only brownish on nose; soles brownish black."

No. 30196, ♀, "iris hazel; feet brownish black; face brown above eyes; chin whitish flesh color."

*Skulls.*

No. 30197, old ♂, total length, 97; zygomatic breadth, 70.	
" 30198, ad. ♂, " " 92; " " 62.	
" 30195, " ♂, " " 95; " " 64.	
" 30199, " ♂, " " 97; " " 70.	
" 30200, " ♂, " " 95; " " 67.	
" 31196, " ♀, " " 91; " " 59.	

These specimens, like the series recorded by me from the Lower Caura in 1904 (*l. c.*), present a wide range of individual variation in depth of color. Thus, of two males in the present collection, one has the limbs strongly suffused with yellowish rufous, and the median line of the back dark rufous, deepening on the posterior part of the dorsal area to reddish chestnut, and the ventral surface bright rufous; in the other the limbs are faintly suffused with pale fulvous, the back with deep yellowish, and the hairs of the ventral surface broadly tipped with fulvous. In the female the upper arms and shoulders are fulvous, the whole dorsal area dull dark brown, and the hind limbs are dark brown with a strong rusty wash. The tail varies from nearly uniform grizzled yellowish brown to grizzled rufous brown, with the lower and upper surfaces nearly concolor, but in one the apical half of the lower surface is yellowish white, and in another there is a subapical area of fulvous about three inches in length.



**Article XIII.**—ON THE GENUS *PRESBYTIS* ESCH., AND ‘LE TARSIER’ BUFFON, WITH DESCRIPTIONS OF TWO NEW SPECIES OF *TARSIUS*.

BY D. G. ELLIOT, D. SC., F. R. S. E., etc.

For some considerable time mammalogists have employed the term *Presbytis* Esch., 1821, for the genus containing the ‘Langurs,’ as antedating F. Cuvier’s genus *Semnopithecus* of 1825. It seems, however, that there are two genera earlier than either of these, *Lasiopyga* Illiger, 1811, and *Pygathrix* E. Geoffroy, 1812. The first of these (*Lasiopyga* Ill. Prodr. Mamm. et Avium, 1811, p. 68) contained two species, *L. nemæus* Linn., and *L. nictitans* Linn., each however, belonging to a separate genus. Illiger did not select either of the species as the type of his genus, and therefore it was perfectly in accord with our code and customs, for E. Geoffroy to select for his new genus *Pygathrix* (Ann. Mus. Hist. Nat. Paris, XIX, 1812, p. 90) the first of Illiger’s species, *L. nemæus* Linn., as its type, thus leaving *L. nictitans* Linn. as the type of *Lasiopyga*, which is antedated by *Cercopithecus* Erxleben, and becomes its synonym.

*Pygathrix*, therefore, being apparently the earliest generic name proposed for the ‘Langurs,’ must be employed, and *Presbytis* becomes a synonym, having been proposed nine years afterwards.

Buffon in his *Histoire Naturelle* described a little animal, which he called ‘Le Tarsier’ and of which he gave an uncolored figure and the following description: “Le poil du Tarsier était une sorte de laine longue de six à sept lignes, fort douce, de couleur cendrée noirâtre sur la plus grande partie de sa longueur depuis la racine, et de couleur fauve-foncée à son extrémité, sur le dos, la croupe et le ventre, et plus claire sur le reste du corps: il n’y avait presque point de fauve sur la tête, elle était grise cendrée, principalement à l’endroit des joues, où il avait du poil long; le cendré paraissait aussi avec le fauve sur tout le corps, les pieds étaient nus.” Then follows a description of the teeth, thirty-two in number, with two incisors on each jaw! The tarsi are bare. This specimen was evidently a young animal as is shown by the blackish gray color of most of the pelage, the brown hue, which characterizes the adults of all the known Tarsier in varying depths from pale to dark brown, not having yet assumed the ascendancy. The fact of this specimen having had but two incisors in the upper jaw, either proves that it was immature, or else all other described Tarsier belong to a different genus, for the adults all have four incisors in the upper jaw. There

is one exception, the *T. bancanus* Horsfield from Java, which is stated to have had but two upper incisors, but as it is also described as having had but five teeth in the molar series on each side, it is evident the last molar had not yet appeared, and it had not obtained its full complement of teeth, otherwise it would represent still another generic form, as Buffon's Tarsier had the usual six teeth in the molar series, viz., three premolars and three molars on each side of both jaws. The question now arises what was this animal described by Buffon, and what species among the known Tarsier does it represent? So long as but one species was recognized, there was no difficulty in giving it a name, *Tarsius spectrum* of Storr & Pallas, founded upon Buffon's description and figure, but as soon as more species were known, the difficulty at once arose, as to which one of these represented the original 'Tarsier,' for Buffon gave no locality for his specimen.

The species with bare tarsi all come from the Philippine islands, consequently it must be one of those known, or one yet undiscovered. But Buffon's example was a young animal, and the young of all the bare-legged Tarsier are so much alike as to be indistinguishable if the locality whence they come is unknown. There are three forms in the Philippines which have received names, *philippensis*, *sanghirensis* and one about to be published by Mr. G. S. Miller, and it is impossible to say that "Le Tarsier" does, or does not, belong to one of these. We have no right to guess at its habitat and so arbitrarily fix one for it, and compel some recognized species, whose habitat is known, to have its name become a synonym. We only know that "Le Tarsier" belongs to the group with bare tarsi and nearly naked tail, but which species of the group it represents is not possible to state. As, therefore, there is no way to define, without doubt, the status of Buffon's "Le Tarsier," it must take its place among those forms that are indeterminable and *Tarsius spectrum* must be dropped from the list of recognized species. All other known species of *Tarsius*, from islands outside the Philippine Archipelago, have the tarsi haired to the ankles.

#### ***Tarsius saltator* sp. nov.**

*Type locality.* Island of Billiton. Type No. 124992 U. S. Nat. Museum.

*Gen. char.* Tail bare save apical third which is sparsely haired, tarsi hairy to the ankles, foot haired to toes, mandible short, and ascending ramus comparatively narrow; teeth smaller than Bornean or Philippine examples.

*Color.* Forehead, sides of face and neck, upper lip and narrow collar from beneath ears passing above shoulders and across back between shoulders rusty; top of head and back of neck to back wood brown, hairs tipped with black and these tips cause the brown beneath them to appear darker than wood brown when looked at from above; middle of back buff; rumps ochraceous; thighs tawny ochraceous, darker than rump, outer side of arms and legs below knees ochraceous buff; inner

side of arms whitish buff; under parts of body and inner side of legs cream buff; base of fur slate-colored and this shows through on underparts almost becoming the dominant hue; throat and upper part of breast rust color. The throat is really bare in the type, but the fur on chin, sides of throat and breast at base of throat is rust color, and it is deemed probable that the rest of throat would be the same or very similar; hands and feet buff; fingers and toes reddish brown; tail at base covered with cream buff fur; hairs on apical third dark brown; bare portion of tail prout's brown grading into brownish black on skin, "dull reddish brown in life" (collector); ear furred at base, remainder bare dark burnt umber.

*Measurements.* Total length, 361; tail, 228; foot, 68 (collector). Skull: total length, 37; occipito-nasal length, 35; hensel, 23.3; intertemporal width, 23; zygomatic width, 26.5; palatal length, 13.9; width of palate between last molars, .9; median length of nasals, .48; length of upper molar series, 15.1; length of mandible, 24.1; length of lower molar series, 12.5.

The type is an adult female and is rather conspicuous for its rusty color and the paleness of the lower back and rump when contrasted with the rest of the upper parts. It is paler and the thighs redder than Bornean or Philippine examples and its furred tarsi at once separate it from the latter species, and its bare tail from the Celebes *P. fuscus*. From *T. bancanus* Horsfield from Java it differs in its rust color and lack of gray anywhere in its pelage, and in having the foot haired. Horsfield's description is not very full, but what he gives of the color of his specimen does not accord with the present type, but his specimen was immature and consequently it is impossible to say what color the adult would have, and I do not have any Javanese examples for comparison. As a rule the immature Tarsier is darker and more grayish than the adult. Horsfield's description of *T. bancanus* is also of an immature individual and he gives no skull measurements, so it will be necessary to have a specimen from Banka, Java, the type locality, to ascertain what it is.

### ***Tarsius borneanus* sp. nov.**

*Type locality.* Sandak River, Borneo. Type No. 142242, U. S. Nat. Mus.

*Gen. char.* Tarsi haired to the ankle, foot to toes; apical third of tail haired, rest bare except at root; molar series larger than in *T. saltator*, palate longer.

*Color.* Forehead, top of head and sides of face rusty; middle of back, outer side of arms, and lower back grayish brown; rump smoke gray; outer side of legs slaty gray with a rusty patch below knee; inner side of arms whitish gray; of legs mouse gray; face ochraceous buff; throat and chest brownish, the slate gray of base of fur dominating the brown; rest of under parts slate gray; hairs tipped with whitish; tail whitish gray at root; bare portion reddish brown, paler beneath, haired part grayish brown darker at tip; feet reddish brown; hands and toes darker brown; ears blackish brown.

*Measurements.* Total length, 310; tail, 190; foot, 69 (collector). Skull, total length, 36.1; occipito-nasal length, 33.6; hensel, 22.1; intertemporal width, 23.1;

zygomatic width, 23.8; palatal length, 14.6; width of palate between last molars, .84; median length of nasals, .64; length of upper molar series, 12.3; length of mandible, 23.4; length of lower molar series, 12.5. Skull of an old adult: total length, 39.3; occipito-nasal length, 36.4; hensen, 26.1; intertemporal width, 28; zygomatic width, 28.4; palatal length, 14.3; width of palate between last molars, .93; median length of nasals, .58; length of upper molar series, 12.9; length of mandible, 27.5, length of lower molar series, 13.7. Skull only, no skin.

From *T. philippensis* this form can at once be distinguished by the hair covering the tarsi and foot; and from *T. saltator* by its larger molar teeth, wider and longer palate, narrower occipital region of the braincase. The type in color resembles closely an example of *T. philippensis* about the same age from Mindanao, Philippines, and probably therefore the adult would be darker than the Billiton Island specimens. It would seem that the Tarsier from the Philippine Islands are the only forms which have bare tarsi, as Horsfield's figure exhibits the tarsi haired to the heel of the foot, the latter and the toes only being bare.

I am indebted to my friend Mr. G. S. Miller, Jr., Curator of the Department of Mammals in the U. S. National Museum, who loaned me all the specimens of *Tarsius* in the Museum, and so enabled me to describe these new forms.

**Article XIV.**—A NOTE ON *SIPHOSTOMA PELAGICUM*  
(OSBECK).

BY JOHN TREADWELL NICHOLS.

Jordan and Evermann in Bulletin 47 of the U. S. National Museum give the range of *Siphostoma pelagicum* as: "Tropical parts of the Atlantic; occasional in the West Indies; very common in the Mediterranean." Later (p. 2837) the validity of the West Indian records is questioned. This leaves the western limits of the interesting range of the fish practically indeterminate. The collections of the American Museum of Natural History contain a series from drifting Gulf weed in the Atlantic, which helps to define these limits. They were collected from a ship bound from New York out across the Equator. The fishes are from 32° N., 43° W. (1 ♂); 32° N., 42° W. (2 ♀); 32° N., 41° W. (2 ♂ 1 ♀); 31° N., 40° W. (1 ♀); 30° N., 39° W. (1 ♂ 1 ♀); 29° N., 38° W. (3 ♀). The stations are marked (•) on the accompanying sketch chart which has ocean currents indicated by arrows. On the chart are also marked (x) the localities where *Pterophryne histrio* was obtained, as the relationship between the ranges of the two species is interesting. Both were taken at one station, 32° N., 43° W. Just beyond our most southeasterly station for *S. pelagicum* the ship from which collecting was being done experienced fresh trade winds which made further examination of the weed and its fauna impossible, and almost immediately the weed itself, which had been such a prominent feature of the ocean's surface since leaving the coast, disappeared. Both the Pipe Fish and Mouse Fish hide in the drifting *Sargassum* which they resemble so closely as to escape the notice of predaceous fishes. Their habits are then sufficiently alike to probably bring them into competition.

With our specimens of *S. pelagicum* are careful color notes taken when they were fresh from the water. The fish were for the most part pale brownish olive, more or less banded, very variable, but with certain constant marks, as a dark mark at the top of the gill cover. Below this the gill cover is white with two or three yellow or bronze marks. A longitudinal dark mark in front of the eye, and a white blotch near the base of the pectoral fin. Iris generally bronze with a tendency to white below. Vertical white bars on the sides prominent in the female. A well marked male fish had the following colors: Pale brownish olive above. About twelve pale bands across the back, margined in front with dark. Sides anteriorly with short vertical whitish bars alternating with whitish dots, giving a chequered

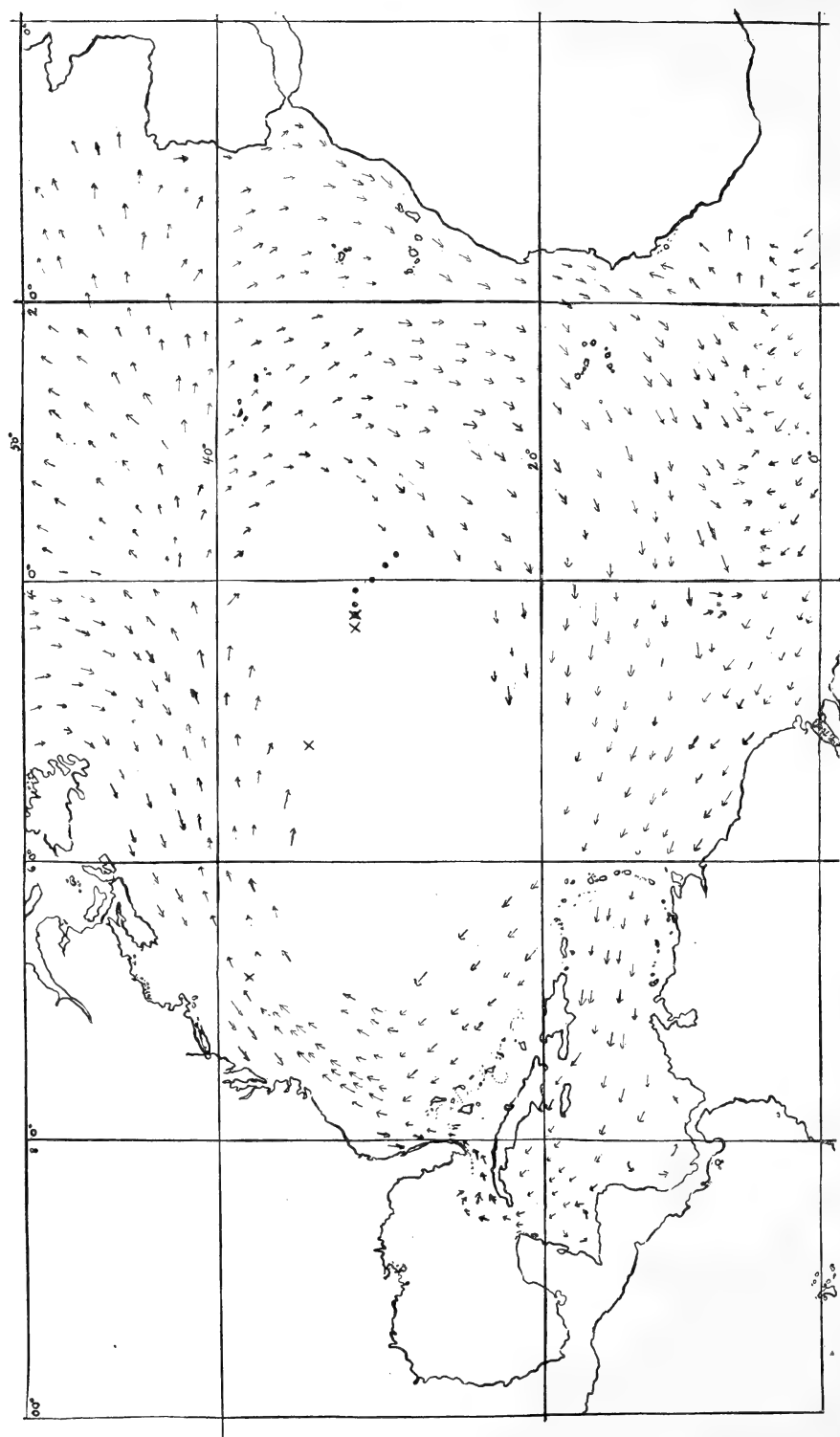


Chart of North Atlantic showing points of capture of *Siphosoma pelagicum* (•) and *Pterophryne histrio* (x).



appearance. (Another specimen had a row of obscure white marks on the sides.) A row of dark marks at each of the two angles of the ventral surface, which anteriorly alternated with the whitish bars, becoming the dark spaces between them on the sides. Dorsal pale with five or six darker marks at its very base. A well marked female fish had the following colors: Pale brownish olive, paler below. Sides with narrow vertical white bands, best defined ventrally, which broadened and faded posteriorly into the lighter spaces between darker bands. A few of these dark bands were decidedly darker than the rest. Still further back the dark bands became imperfect. (In another fish some of the whitish lateral bars extended, faded, across the back to form about thirteen pale bands, each margined in front by darker. This same specimen had the anterior ventral parts yellow.) Dorsal fin pale with vertical marks of darker. A single female fish had the following aberrant coloration: above mottled with blackish, grayish brown and gray, the colors arranged more or less in darker and lighter cross-bands. Marks on the white gill-cover area greenish instead of bronze or yellow. Iris dark, more or less mottled above, white below. Caudal spotted with blackish and whitish at its two edges.



**Article XV.**—A NOTE ON THE IDENTITY OF *CARANX*  
*FORSTERI* CUVIER & VALENCIENNES.

BY JOHN TREADWELL NICHOLS.

The writer has recently had occasion to examine the type of *Caranx forsteri* Cuvier & Valenciennes in the Paris Museum, No. 111-214-a, from Isle-de-France, and also specimens from Malabar and Celebes on which the species was no less based. The specimens are in good condition, and belong to a species quite distinct from that described from the Hawaiian Islands as *Caranx forsteri* in Vol. 23, Bull. U. S. Fish Commission for 1903, which fish is much closer to, if indeed it is different from *C. latus* Agassiz.

The types of *Caranx marginatus* Gill and *C. rhabdotus* (Jenkins) in the U. S. National Museum, as also the description and plate of *C. elecate* (Jordan & Evermann), Vol. 23, Bull. U. S. Fish Commission for 1903, have been examined and the three names are considered synonyms of *Caranx forsteri* Cuvier & Valenciennes.

A diagnosis of *Caranx forsteri* as here understood follows: A rather fusiform fish, with rounding forehead-outline suggesting *C. hippos*, but not so high. Margin of gill opening either plain or with a small spot above. No spot on its posterior margin as in *Caranx hippos*. Head about 3.5 in length to notch of caudal fin. Depth about 3 to 3.5. Eye about 4 to 4.5 in head. Maxillary 2.1. A single row of rather small teeth in jaws. Breast scaly. Curve of the lateral line about 1.6 in straight portion, on which are about 30 scutes, those on peduncle noticeably broad. Soft dorsal and anal moderately falcate. Pectoral about equal to head. D. about VIII-I, 20. A. II-I, 16. The most noticeable characters are the scaly breast, curved frontal outline, broad scutes on peduncle, and low vertical fin-ray count. As defined the species is a variable one, but it is a natural and readily recognizable unit which will apparently not bear subdivision.



## Article XVI.—ON TWO NEW BLENNYS FROM FLORIDA.

BY JOHN TREADWELL NICHOLS.

***Stathmonotus tekla*<sup>1</sup> nov. sp.**

A single specimen (American Museum No. 2536), 19 mm. long obtained in a few inches of water on rocky shallows at Sand Key, off Key West harbor, Florida, Feb. 24, 1910; a place frequented by small Pomacentrids, wrasses, and surgeon fishes. Color tawny; orbital cirri whitish; lateral line posteriorly with linear dark red-brown marks; dark bars on cheeks. In spirits colors much faded. Body narrow and strongly compressed. Head 5 in body. Depth 6. Eye 4 in head. Mouth large, the jaws about equal. Teeth in jaws rather large, conical, curved, apparently but a single row. Body scaleless. Orbital cirrus  $\frac{3}{4}$  diameter of eye, with a broad flat expanded end. Gill membranes broadly united. Lateral line present, poorly developed. Pectoral well developed, with 8 or 9 rays, about  $2\frac{1}{2}$  in head. Ventral long and slender, 2 rays, placed far forward, about 2 in head. Dorsal origin about opposite middle of pectoral. The fin entirely made up of spines, shortest anteriorly, last spine joined from near its tip to the rounded caudal, which is practically unjoined to the anal fin. D. X L. A. II, 23, the spines slightly shorter than the rays.

This little fish belongs rather with the arctic than the tropical Blennys. Its occurrence at Key West would be surprising were it not that its nearest ally, *Stathmonotus hemphilli*, came from there also. From this species it differs considerably, notably in the large orbital cirrus, larger pectoral and ventral, and different fin-count.

***Blennius fabbri*<sup>2</sup> nov. sp.**

We have one small specimen (American Museum No. 2537), 15 mm. long, taken from seaweed in shallow water at Miami, Florida, Jan. 24, 1910. Color when alive, tawny, mottled, forehead white. In spirits greyish with pale blotches. Head equals depth, 3.2 in body. Eye 3 in head. Teeth comblike, in a single row in jaws. No apparent canines. Body scaleless. A simple, rather stout, pointed orbital cirrus about  $\frac{1}{2}$  diameter of eye. A rather long external nasal tube. Gill membranes united, free from the isthmus. Lateral line incomplete, not reaching tip of pectoral. Pectoral about equal to head. Ventral long and slender, 1.5 in head. Dorsal XI, 18, the rays slightly longer than the spines,—the last one joined to the caudal. A. 20.

This little fish looks like *B. fucorum* from which the shorter orbital cirrus, incomplete lateral line, dorsal-caudal attachment, and different color, distinguish it.

<sup>1</sup> *tekla* — for the yacht 'Tekla' from which the specimen was obtained, and whose owner, Mr. Alessandro Fabbri, has directed extensive fish collecting in Florida in behalf of the American Museum of Natural History.

<sup>2</sup> *fabbri* — in honor of Messrs. Ernesto G. and Alessandro Fabbri, through whose energy and generosity the American Museum has obtained this fish and many other interesting forms from Florida.



**Article XVII.—NEW OR LITTLE KNOWN REPTILES AND  
AMPHIBIANS FROM THE PERMIAN (?) OF TEXAS.<sup>1</sup>**

By E. C. CASE.

REPTILIA.

Order COTYLOSAURIA.

SKULL OF *Diadectes phaseolinus* COPE.

In 1905 (Jour. of Geol., Vol. XII) the author gave a preliminary description of the Diadectidæ based on two specimens in the University of Chicago. The first, No. 1075, is a nearly complete skeleton, but the lower jaws are in position and the skull is preserved in such a refractory matrix that only the external features could be made out. The second, No. 1078, is an imperfect skull. The specimen here described<sup>2</sup> is nearly perfect, lacking only the premaxillaries, the articular portion of the left quadrate and the lower jaws. The preservation is especially favorable as the skull is little distorted and the details of structure can all be made out.

*Upper surface.* The posterior portion is marked by a very coarse sculpture but this does not extend much anterior to the orbits. Beyond this the skull is comparatively smooth except the anterior end of the nasals which are marked by a series of pits arranged in an elongate sculpture. The sutures are so indistinct that the limits of the bones can not be made out. The upper portion of the skull is much narrower than the lower so that the distance across the posterior end of the upper surface is not more than half of that across the articular surfaces of the quadrate bones. The pineal foramen is "enormous" in size. Near the posterior end of the skull there are two deep pits in the position of the superior temporal foramina in the Diapsida; in other specimens I have thought that I detected perforations of the skull at this point but there are certainly none in this skull. The character seems to have been an extremely variable one.

<sup>1</sup> The following descriptions were prepared in the course of work conducted under a grant from the Carnegie Institution of Washington and are published in advance of the final paper by arrangement with the Carnegie Institution and the American Museum of Natural History.

<sup>2</sup> No. 4839, American Museum of Natural History. From the upper layer of conglomerate, in Archer County, Texas, a few miles south of the town of Dundee, discovered by the author.

*Posterior aspect.* The occipital condyle is wider than long and is excavated on the upper border by the foramen magnum so that it presents a broad heart-shaped outline. The articular face for the atlas is concave and there is a deep pit for the continuation of the notochord. The foramina for the exit of the posterior cranial nerves are not apparent, but a deep pit on

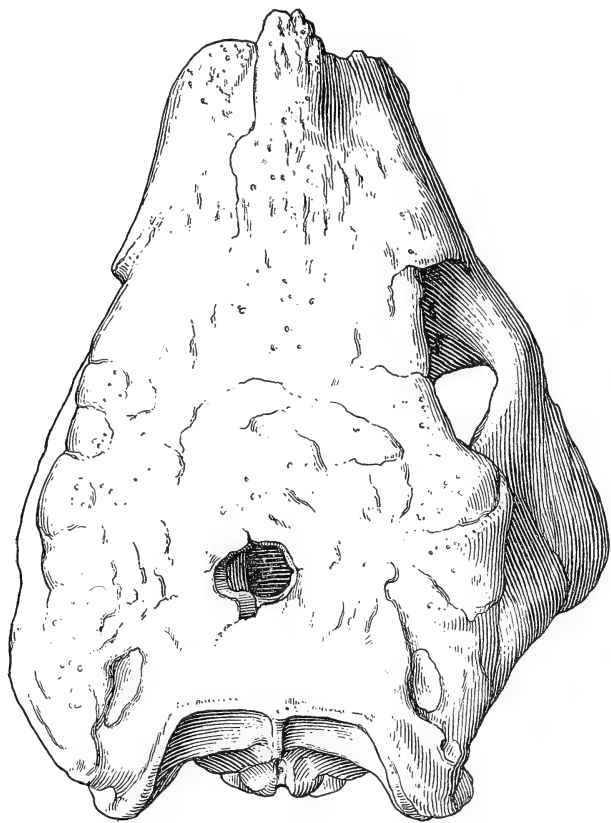


Fig. 1. *Diadectes phaseolinus*. No. 4839, A. M. N. H. Superior aspect of skull.  $\times \frac{1}{2}$  nat. size.

either side of the basioccipital may have led into them. The sutures between the various bones forming the posterior plate of the skull cannot be made out, but it is apparent that the paroccipital bone was very short and joined, almost at once, the descending processes of the squamosal and the quadrate. I have described<sup>1</sup> two perforations in the posterior portion of

<sup>1</sup> Jour. of Geol., vol. XIII, p. 127.



the skull in the position of the post-temporal foramina and likened the condition to that of the turtles; in this specimen I find only two deep pits in this position.

*Lateral surface of the skull.* The quadrate rises almost vertically; the

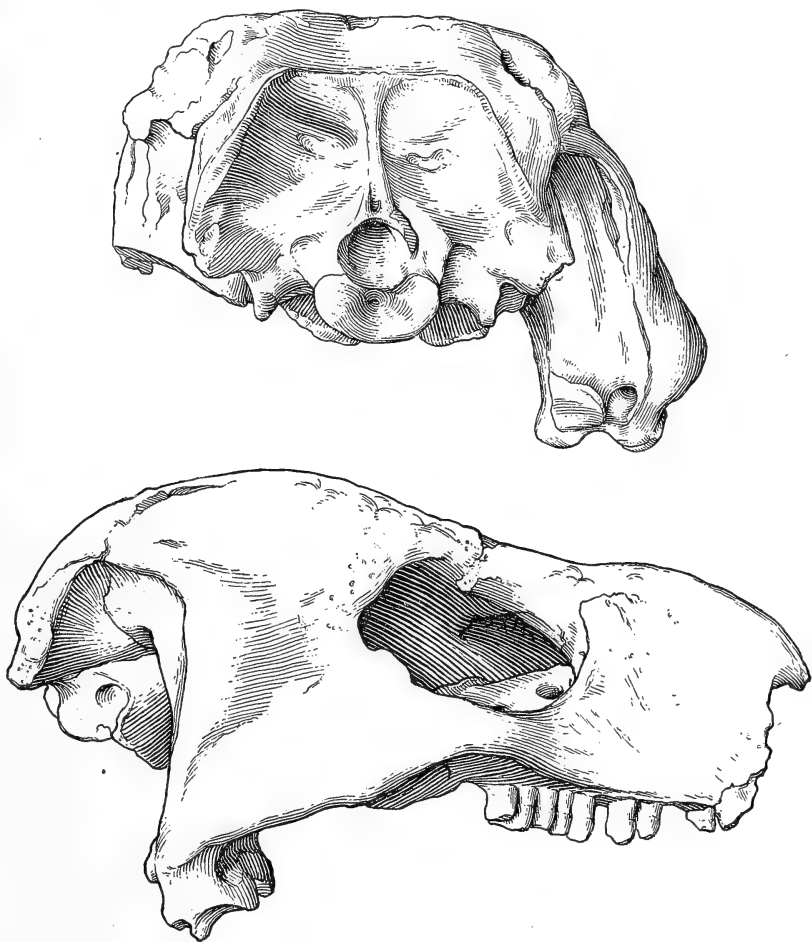


Fig. 2. *Diadectes phaseolinus*. Same skull as in Fig. 1. Posterior and lateral aspects.  $\times \frac{1}{2}$  nat. size.

anterior border is attached to and somewhat overlapped by the bones of the postorbital region; near the upper end the quadrate turns at a sharp angle and joins a process of the paroccipital. The quadrate is quite similar to that of the turtles. No trace of a columella auris was found and if present

it must have been very short and stout. The opening of the auditory canal is not apparent but it must have been almost directly opposite the angle described.

*Lower surface of the skull.* The basioccipital joins the basisphenoid by an indistinct suture. The basisphenoid ends abruptly in front just anterior to the basipterygoid processes. There is no presphenoid rostrum: a short and very stout process excavated longitudinally by a deep pit on its lower

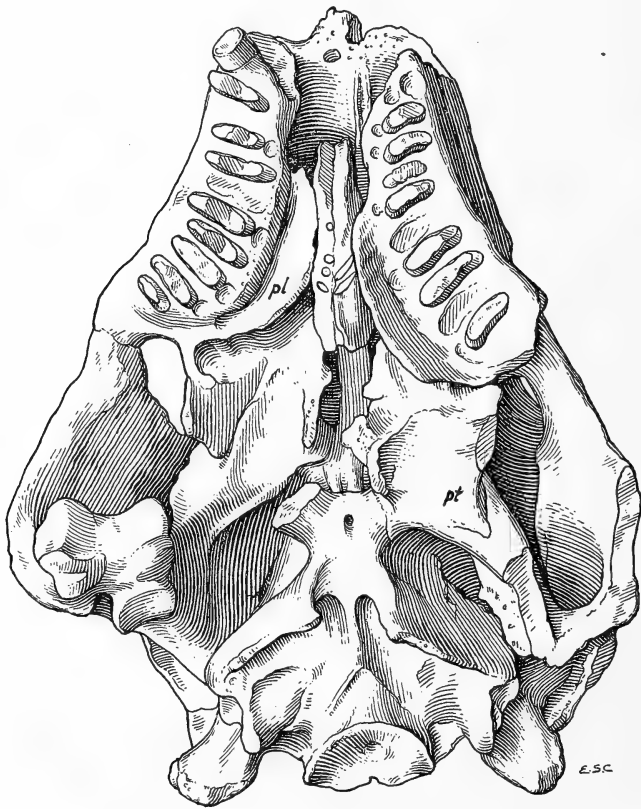


Fig. 3. *Diadectes phaseolinus*. Same skull as in Fig. 1. Inferior aspect.  $\times \frac{1}{2}$  nat. size.

surface is attached to the anterior end of the basisphenoid; in other specimens this region is perfectly smooth. The lower surface of the basisphenoid is penetrated in the median line by a single foramen; in the Pelycosauria and Rhynchocephalia generally, there are two foramina in this position for the passage of the internal carotid arteries. In other specimens of *Diadectes* I noticed no foramina in this position, but one was probably present. Poste-

riorly the basisphenoid widens and the lower edge is continued backward as a sort of flange overhanging the basioccipital. This edge is excavated by a notch in the median line and the notch is divided by a narrow partition which is continued backward as a ridge on the lower surface of the basisphenoid and then divides, probably following the line of the basioccipital-basisphenoid suture. On either side of the dividing ridge there is a deep pit, probably the opening of the Eustachian canals. In the Pelycosauria this is a single pit.

Posterior to their articulation with the basipterygoid processes of the basisphenoid the pterygoids pass backward as vertical plates to join the quadrate, but the vertical plates are curved so as to approximately follow the curve of the outer wall of the skull, and this leaves no great space between them. Anteriorly the pterygoids nearly, but not quite, meet in the median line; passing forward they articulate with the inner edges of the maxillaries or with the palatines. The anterior ends of the pterygoids are covered by plates attached to the maxillaries; these occupy the position of palatines and probably are such, but their position underlying the pterygoids is very peculiar. In other specimens I have traced an incomplete ectopterygoid but none can be made out in this one. Between the maxillary plates (Cope), or palatines (Case), there is left quite a space in which lie the prevomers. These are vertical plates of considerable height but very narrow on the palatal surface. The upper edges of the posterior ends flare out to join the pterygoids or palatines, but at the anterior end the plates are strictly vertical and touch at the upper edge a single vertical plate in the median line of the skull. There are traces of a few elongate, conical teeth, irregularly arranged, on the lower surface of the prevomers.

*Longitudinal section of the skull.* The brain-cavity shows the sharp downward bend posterior to the epiphysis mentioned by Cope in his description of a cast of the cranial cavity. Anterior to the otic region there is a very large foramen which probably gave exit to the seventh cranial nerve: it is likely that other nerves escaped through the same opening. Anterior to this foramen, the walls of the brain case are formed by solid descending plates, the alisphenoids, attached to the under side of the roof above and uniting with each other and the basisphenoid below; they may be traced forward as far as the anterior edge of the orbit, meeting in the mid-line below and forming a long cavity open at the anterior end, which sheltered the long anterior prolongation of the brain shown in Cope's cast.

Anterior to the basisphenoid and joining the short anterior rostrum is a single vertical plate, the parasphenoid (ethmoid). This ends somewhat abruptly behind the point where it joins the basisphenoid, but extends upward until it unites with descending plates above. It remains in contact

with these plates to their anterior end, and beyond them, it is united by cartilage to a median prominence on the lower surface of the nasals. The lower edge of its anterior half is in contact with the upper edges of the prevomers. This plate is similar in all respects to the bone figured by Broom as the ethmoid in the skull of *Lystrosaurus latirostris* and by the author in the skull of *Dimetrodon gigas*. It is a direct continuation of the parasphenoid rostrum of the basisphenoid, even if it is not a part of it. In the Pelycosauria there is a well developed presphenoid rostrum and in the

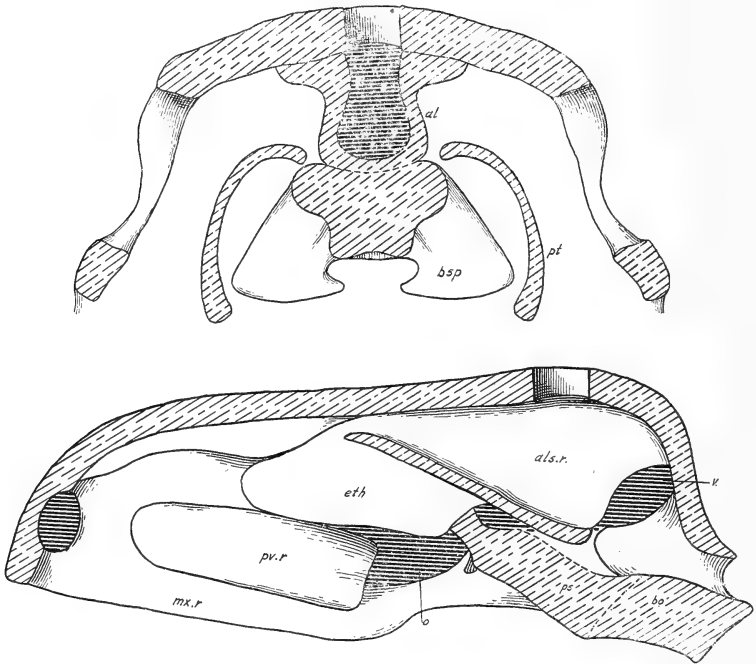


Fig. 4. *Diadectes phaseolinus*. Upper figure, a transverse section of the skull at center of orbits. *al*, alisphenoid; *pt*, section of pterygoid; *bsp*, basisphenoid. Lower figure, a longitudinal section of the skull. *als.r*, alisphenoid, right side, seen from within; *eth*, ethmoid; *pv.r*, prevomer, right side; *mx.r*, maxillary, right side; *o*, orbit; *ps*, basisphenoid; *bo*, basioccipital; *v*, opening for seventh, and perhaps other cranial nerves.

specimen described below, *Dimetrodon gigas*, the ethmoid is directly attached to its anterior end. It is my belief that this plate is in part, at least, derived from the parasphenoid and represents the beginning of the unpaired vomer as stated by Broom. The anterior, toothbearing, paired elements are true prevomers.

In the article in the 'Journal of Geology' the author suggested the possible relationship of *Diadectes* to the turtles on the following counts:

- I. The form and relations of the quadrate.
- II. The degenerate palate and the disappearing transverse bone.
- III. The absence of teeth on the palatines and pterygoids.
- IV. The absence of a parasphenoid rostrum on the basisphenoid bone.
- V. The absence of prevomers and the presence of an anteriorly placed single vomer (parasphenoid).
- VI. The method of entrance of the internal carotids into the brain cavity.

VII. The presence of paired descending plates from the roof of the skull anterior to the brain case.

Of these numbers, IV, V, and VI must be modified.

IV. Several specimens show no trace of the parasphenoid rostrum; this one shows a short and degenerate process. Versluys has recently shown the presence of a parasphenoid in *Dermochelys*.

V. This is wrong. There is a separate parasphenoid (ethmoid, vomer) and distinct paired prevomers in the median line.

VI. In some other specimens there are no foramina perforating the lower surface of the basisphenoid, in this there is a single large foramen.

The corrections do not modify the conclusions drawn in the first paper.

#### RECONSTRUCTION OF *Diadectes phaseolinus* COPE.

This reconstruction is based on specimen No. 4684, Am. Mus. Nat. Hist. It consists of a nearly anatomically perfect skeleton, lacking only the skull, the atlas and axis, a few caudal vertebræ and many of the bones of the feet. The lower jaw is in good preservation and shows that the animal belongs to the same species as the skull, No. 4839, described above, so the only points left in doubt are the structure of the carpus and tarsus, the number and arrangement of the phalanges and the exact number of caudal vertebræ. The specimen was found in the upper conglomerate layer on the south side of Godlin Creek, in Archer Co., Texas, by the author in 1908. The skeleton was worked out and reconstructed by Charles Falkenbach of the American Museum.

In 1907 the author published a reconstruction of *Diadectes* based on the very perfect skeleton in the University of Chicago but the present specimen indicates several errors, notably in regard to the plates overlying the anterior ribs and in the length of the tail. The form and proportions of the present reconstruction are subject to little doubt. The position of all the presacral vertebræ has been determined by fits between the fragments with the exception of a single place; this renders the position and number pretty certain,

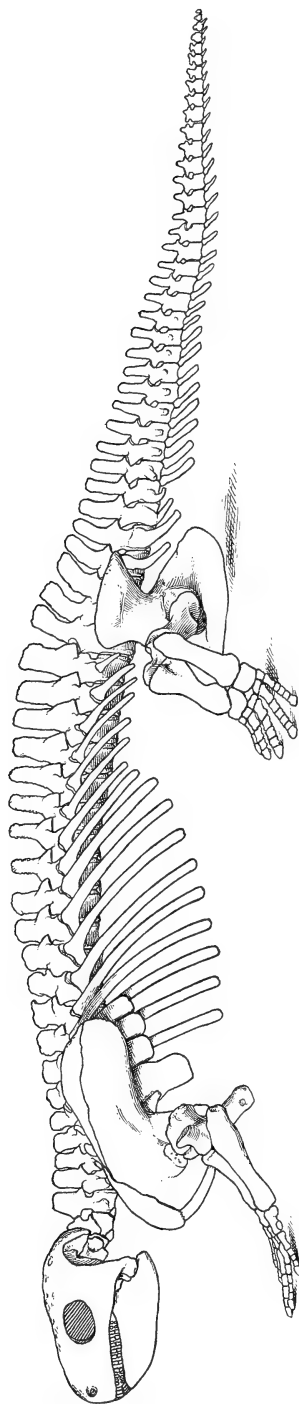


Fig. 5: Reconstruction of the skeleton of *Diadectes phascolinus*.  $\times \frac{1}{11}$  nat. size.

but if we add the axis and atlas there is one more vertebra than in the Chicago specimen.

The *atlas* as shown by the Chicago University specimen number 1075, has a simple disk-like centrum with the neural arch composed of two separate halves. These latter strongly resemble the same elements in *Dimetrodon*. The articular face of the occipital condyle is placed at a strong angle to the main axis of the skull, so that if it articulated directly with the face of the atlas the skull would have been held at an angle to the vertebral column; to avoid this there must have been a large preatlantal intercentrum.

The *axis* resembles the succeeding vertebræ in general form but the spine is thinner and expanded somewhat antero-posteriorly. It is not greatly higher than the spines of the other vertebræ.

The remaining cervicals and the dorsals are similar in form. The neural arches are broad and strong, the zygapophyses are flat and there is a well developed hyposphene-hypantrum articulation throughout the presacral series. The spines are all stout and low with slightly expanded, very rugose upper ends which are strongly suggestive of the presence of a row of dermal plates overlying the neural spines as in *Pareiasaurus*. No trace of such plates has been observed in any specimen, however. There are no true lumbar in the sense of any vertebræ being without ribs, for the first presacral has a short rib coössified with the transverse process. There are two sacral vertebræ, not united into a sacrum, but with reduced zygapophyses and evidences of a very close union between them. The anterior caudals, up to the fourth or fifth, have free ribs, beyond this the ribs are ankylosed to the transverse processes and are rapidly reduced to a rudimentary condition. The tail is as long as the presacral portion of the column, but the vertebræ do not assume the elongate form which indicates the presence of a very slender tail. Between the fifth and the sixth vertebræ the first chevron appears and these continue to the extremity of the tail. The chevrons and the spines of the caudal vertebræ indicate that the tail was somewhat flattened vertically as in the alligators.

*Intercentra* of small size occur in the specimen in Chicago but are not preserved in this specimen.

*The ribs.* The atlas probably bore a pair of slender ribs of considerable length, but this is indicated very imperfectly in the specimen. The ribs of the axis are short but broader, showing an approach to the triangular form of the three following ribs. The ribs of the third, fourth and fifth vertebræ show a well defined articular end with a distinct neck, but in common with all the rest of the ribs there is no division into capitulum and tuberculum. The bodies of these ribs are expanded into thin triangular plates, with the front edge straight and the posterior edge drawn out into a point which

overlaps the succeeding rib; this forms a strong protection for the anterior thoracic region. The following ribs are of normal form, gradually increasing in size to the eighth or ninth and then decreasing. The sixth, seventh and eighth are overlain by thin, narrow, plates which continue backward the protection of the thoracic region to a point opposite the posterior end of the scapula. In the first restoration of *Diadectes* it was thought that the expanded anterior ribs were also plates overlying the ribs, but this is shown to be an error.

The bones of the *shoulder girdle* are separated but show the same character as previously described; the animal was distinctly narrow chested, with the bones of the girdle strongly interlocked. The anterior edge of the clavicle was so far forward that it was very close to the angle of the lower jaw. In common with many of the Permian and Triassic reptiles, *Diadectes* had practically no neck.

The *limbs* were exceptionally stout and short and the feet very wide and stumpy. There are only a few of the carpal and tarsal bones preserved. In the reconstruction they have been placed as nearly in the correct position as possible, but the result is very doubtful. The metapodial bones are all very broad and short and the terminal phalanges are spatulate and rugose, showing the presence of a broad, blunt nail.

The *pelvis* is complete but has been badly crushed in fossilization so that it is much too narrow and the ischium and pubes are not horizontal as they were in life. The ilium rose almost vertically and at right angles to the other two bones.

No trace of *abdominal ribs* have been found in any specimen of *Diadectes* but it seems probable that such elements were present. They occur in most of the reptiles of the Permian which are related in form or habit to the Diadectids.

The appearance of this creature, with its large head, short neck, narrow chest and round body; with its short stumpy legs and feet resembling those of a land turtle, and its alligator-like tail, must have been sufficiently bizarre, but not more so than that of many living reptiles. Perhaps *Heloderma* would be the most similar among living forms in attitude and proportions, if the cylindrical tail were compressed into that of an alligator, the feet shortened and the claws blunted. It is difficult to form any idea of the habits except that the animal was herbivorous, of low brain power and sluggish movement, and it can only have offered a passive defense to such animals as the carnivorous Pelycosaurs. The strong girdles, the powerful limbs with well formed articulations and especially strong rugosities for muscular attachment, the closely knit and well formed carpus and tarsus all indicate a terrestrial habit. The broad, short feet with powerful spade-



like terminal phalanges which were covered by powerful nail-like claws have strong resemblances to those of certain fossorial forms such as the gopher turtle of Florida, *Gopherus polyphemus*. It seems probable that the foot rested fairly flat on the ground with a pad raising the carpus and tarsus slightly. A small fragment of shale from the same region in which this specimen was found carries two footprints of a smaller animal, probably a Diadectid; in this only the impression of the claws and of a flat pad are shown.

I believe these animals to have been harmless, sluggish, terrestrial herbivores; possibly fossorial in habit, at least to the extent of excavating burrows

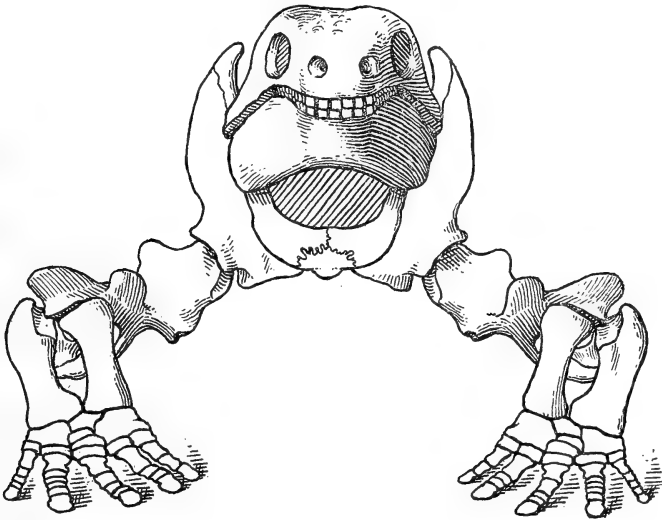


Fig. 6. Reconstruction of the skeleton of *Diadectes phaseolinus*.  $\times \frac{1}{2}$  nat. size.

for their protection. The attitude was habitually prone and they could not elevate the body on the limbs even as much as an alligator can, nor could they develop any speed even for short intervals. Finally: These Diadectids, the type forms of the Cotylosauria, can not be retained in the ancestral position in which Cope placed them, the Rhynchocephalian double arch can not be derived from the skull and the animal is otherwise too highly specialized. The mounted skeleton bears out in form, proportions, attitude and probable habit, the suggestions previously made by the author that these animals are the nearest discovered forms to the ancestors of the turtles.

## NEW REPTILES.

**Diadectes maximus** sp. nov.

Type: Three large lumbar vertebræ. No. 4392, Am. Mus. Nat. Hist., Cope Coll.

This species is indicated by the not uncommon occurrence of especially large bones of this genus. Size, however, is not sufficient alone to indicate distinction among the reptiles. Three large vertebræ give certain characters sufficiently distinct to warrant the separation of the species. These are from the posterior portion of the column and are of a size to go with such femora as are indicated by the fragmentary specimens Nos. 4361 and 4379, Am. Mus. Nat. Hist., Cope Coll. The vertebræ differ from other known forms in their greater size and in having the faces of the hyposphene and hypantrum nearly horizontal instead of being inclined at an angle of nearly  $45^{\circ}$  to the vertical axis.

*Measurements.*

	mm.
Height from the bottom of the posterior edge of the centrum to the base of the spine . . . . .	146.5
Height of the posterior face of the centrum . . . . .	58.5
Length of bottom line of the centrum . . . . .	48.
Width across the zygapophyses . . . . .	140.

The femur, No. 4361, Am. Mus. Nat. Hist., Cope Coll., is represented by a crushed fragment which is 122.5 mm. across the proximal end. The second femur is also crushed; in its present condition it has a width across the distal end of 138.5 mm. and a length of 261 mm. An anterior caudal vertebra, No. 4838, Am. Mus. Nat. Hist., has a total height from the base of the centrum to the top of the spine of 182 mm. and a width across the transverse processes to the beginning of the ribs of 83 mm. These bones indicate an animal at least one third larger than the reconstructed specimen No. 4684.

**Diasparactus zenos** gen. et. sp. nov.

Type: A short series of vertebræ, including the sacral and a few pre-sacral vertebræ. No. 4797, Am. Mus. Nat. Hist., Cope Coll. From New Mexico. (Fig. 7, upper row.)

This new genus and species of the family Diadectidæ is characterized by the small size of the centra compared to the height and spread of the neural

arches and by the short transverse processes. The whole vertebra is relatively very thin antero-posteriorly so that while it has the general form of all members of the family, it looks much higher and wider and the small centrum gives it something of a high-shouldered kite shape, when viewed from the front or rear. The transverse processes are exceedingly short, never extending out beyond the edges of the zygapophyses and in most cases not reaching so far.

The last perfect vertebra in the series presents an abnormal condition.

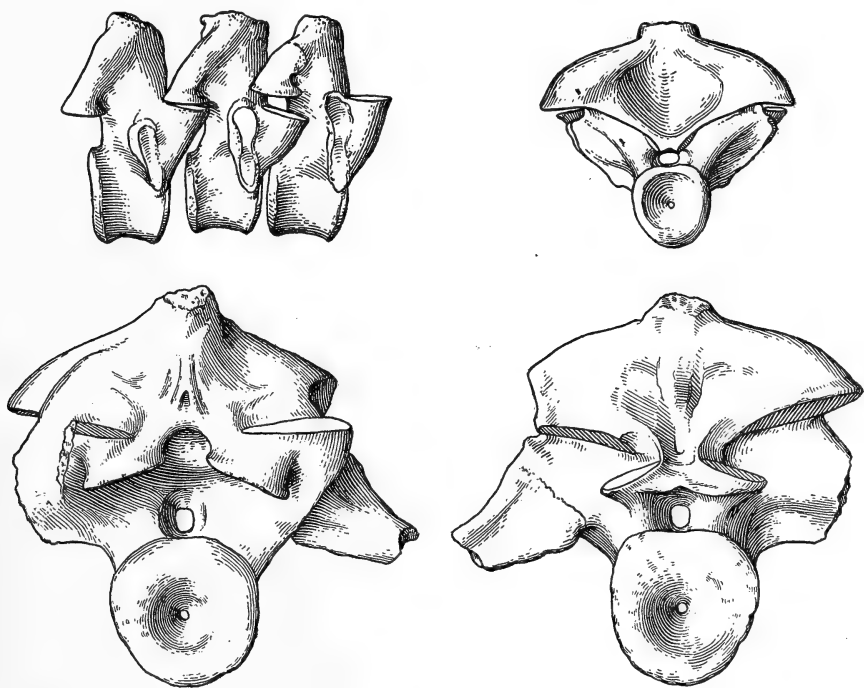


Fig. 7. Upper row: *Diasparactus zenos*, type vertebræ, No. 4794, A. M. N. H., lateral and posterior aspects.  $\times \frac{1}{2}$  nat. size. Lower row: *Diadectes maximus*, type vertebræ, No. 4392, A. M. N. H., anterior and posterior aspects.  $\times \frac{5}{16}$  nat. size.

On the right side the transverse process is reduced to a mere rudiment. On the left side, there is a short, strong process with a large face for the sacral rib. A fragment of the vertebra succeeding has the appearance of carrying a large face on the right side. It is evidently a case of an abnormal support of the pelvis.

The first presacral has only small transverse processes without articular facets for ribs. The second presacral has a very short transverse process which is inclined very slightly forward at the lower end; the upper end hardly

overhangs the lower. In these respects it differs from *Diadectes* in which the articular face is inclined sharply downward and forward. In the anterior vertebræ the faces of the transverse processes become longer but remain nearly vertical. In all, the transverse process is so short as to be practically absent and the upper end of the articular face is on the posterior surface of the anterior zygapophysis.

*Measurements.*

	mm.
Transverse diameter of a centrum . . . . .	23.
“ “ “ same centrum, bottom line . . . . .	12.
Antero-posterior diameter of same centrum . . . . .	20.
Height of vertebra to base of spine . . . . .	63.
Width across posterior zygapophyses . . . . .	66.
Anterior-posterior width across zygapophyses . . . . .	37.

There are isolated vertebræ of Diadectid reptiles in the collection which exhibit the same relative shortness antero-posteriorly as is shown in No. 4797, but do not have the proportionately small centrum nor short transverse processes. It may be that they indicate a new genus but we know so little of the osteology of these animals that it may well be that they are lumbar vertebræ of some form already described from the teeth and so no new name is proposed.

***Ctenosaurus rugosus* sp. nov.**

Type: A few neural spines. No. 4785, Am. Mus. Nat. Hist., Cope Coll. From Rio Arribas Co., New Mexico.

Among the fragments bearing the same number as the type specimen of *Zatrachys apicalis* are several spines of a Pelycosaurian reptile which indicate a new species of the genus *Ctenosaurus*. This genus has not previously been recorded from North America but Dr. Matthew has located in the collection of the American Museum certain spines from Texas which are very similar to *Ctenosaurus koeneni* of von Huehne. It is probable that this genus or something very similar to it existed in North America. The spines here described are not very long, the base is narrowed with almost equal antero-posterior and transverse diameters. The upper portion becomes more thin and is elongated in the antero-posterior direction. The sides of the spine from the base to the top are covered with small irregular bosses similar to that on the skull of many amphibians. Some of the spines are more slender and less expanded antero-posteriorly at the top than others but all bear the characteristic sculpture. Fragments of scapulæ and limb bones associated with the spines are typically Pelycosaurian in form.

	mm.
Height of a nearly complete spine . . . . .	113.
Antero-posterior diameter at top . . . . .	30.
Same at bottom . . . . .	15.

**GYMNARTHRIA** subord. nov.

**Gymnarthridæ** fam. nov.

Skull without temporal openings. Lower edge of postorbital portion cut away by the development of a notch until the quadratojugal is lost and the prosquamosal greatly reduced. Quadrate freely exposed and perhaps movable. Parasphenoid rostrum large. Distinguished from *Lysorophus* by the single occipital condyle, loss (?) of prosquamosal and quadratojugal, and character of the teeth.

**Gymnarthrus willoughbyi** gen. et sp. nov.

Type: A skull. No. 4892, Am. Mus. Nat. Hist. From Baylor Co. near the head of Coffee Creek, in a red clay above the Wichita Conglomerate.

Paratype: A skull. No. 4763 Am. Mus. Nat. Hist. Cope Coll. Locality unknown.

The description given is taken from the type largely, but additional facts have been determined from the paratype.

Teeth blunt cones with no indication of anterior and posterior cutting edges. Teeth regularly decreasing in size anteriorly. No enlarged teeth in premaxillaries. Nine teeth in maxillary and three or four in the premaxillary.

The type skull is small, total length slightly over 16 mm. The premaxillaries are imperfect, so it is impossible to give the exact length. At first sight the skull resembles that described by Cope as *Pariotichus* but it is radically different in the posterior portion. The lower edge of the postorbital region has been cut away in the manner of some turtles, until the quadratojugal is lost, the prosquamosal doubtfully present, and the quadrate fully exposed and perhaps movable. The upper portion of the skull is roofed over and there is no suggestion of temporal openings. The quadrate is elongate and of peculiar shape; it articulates with the squamosal above and seemingly with the occipital plate (paroccipital + exoccipital + supraoccipital) behind. The posterior surface is somewhat injured and it is impossible to make out the form and relations of the various bones. The relations of the bones of the upper surface is shown in Fig. 8D. There is a small but distinct parietal foramen. The premaxillaries were apparently large and

sent back a process between the nares to meet the nasals. The anterior nares were of good size and terminal in position. The last maxillary tooth is small, the next to the last is the largest and the others diminish regularly toward the anterior end. There are no tusks or enlarged teeth on the premaxillaries, the teeth on this bone sharing in the regular diminution in size toward the anterior end of the skull. There are no cutting edges on the antero-posterior faces.

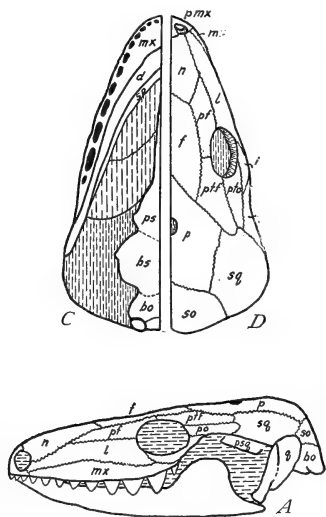


Fig. 8. *Gymnarthrus willoughbi*, type skull, No. 4892, A. M. N. H. A lateral, and D superior aspects.  $\times \frac{2}{3}$  nat. size.

On the lower surface the basioccipital occupies a small space at the rear, the basisphenoid is a large flat plate, and unites without suture with a strong parasphenoid process. It was thought at first that both the basisphenoid and the parasphenoid process constituted the parasphenoid bone and that the animal was an amphibian, but this is impossible. The parasphenoid process is relatively the largest in any of the Permian reptiles recovered from Texas and in this respect, the animal approaches the intermediate form between the amphibians and reptiles. At the anterior end, the parasphenoid meets two diverging plates which are apparently the palatines but they are in large part covered by the lower jaws. The lower edge of the pterygoids can be made out as a thin line in the matrix which fills the back part of the skull; its relations to the basisphenoid and quadrate are normal.

The lower jaws lie in position between the upper jaws and the teeth cannot be seen. The articular region is low and just anterior to this the upper edge rises in a prominent coronoid process. The different bones of the jaw cannot be made out, but it is apparent that the dentary takes part in the symphysis.

The paratype shows that the pterygoids are large flat plates reaching the middle line, not widely separated as in amphibians. The type skull shows two small openings between the orbits and nares which were supposed to be preorbital openings but as nothing of this kind appears in the paratype, they are probably accidental.

The nearest approach to this form is the small amphibian skull described by Broili as *Cardiocephalus sternbergii*,<sup>1</sup> but this is described as having the

<sup>1</sup> 'Permische Stegocephalen und Reptilien aus Texas.' *Paleontographica*, Bd. LI, s. 45, Taf. vi, fig. 5.

skull complete, no parietal foramen, teeth regularly diminishing in size anteriorly but with cutting edges, and lyra present.

## AMPHIBIA.

### Order TEMNOSPONDYLI.

#### **ASPIDOSAURIDÆ** fam. nov.

#### **Aspidosaurus glascoeki** sp. nov.

Type: A fragmentary skull and portions of the vertebral column. No. 4864, Am. Mus. Nat. Hist. Collection of 1908. From the upper conglomerate layer a few miles south of Dundee, Archer Co., Texas.

This specimen is similar to those described by Cope as *Zatrachys apicalis*, by Case as *Z. crucifer*, and by Broili as *Aspidosaurus chiton*. Cope mentioned that he considered as belonging to the genus *Zatrachys* all forms of amphibians with serrate edges of the skull and with expanded rugose terminations of the neural spine. There is no evidence in the Cope Collection or elsewhere for the union of such forms in a single genus. The genus *Zatrachys* was originally described from skulls alone and the species *apicalis* and *crucifer* were described from fragmentary dorsal spines. The present specimen shows that the expanded neural spines are not connected with a skull of the type of *Zatrachys* but with one more like that of *Trimerorhachis*. As there seem to be several distinct genera with the expanded neural spines, and as there is no place for them, I propose a new family **Aspidosauridæ** for *Aspidosaurus chiton* Broili, *A. (Zatrachys) apicalis* Cope, and *A. (Zatrachys) crucifer* Case. This family is characterized by the rhacitinous vertebræ, by the expanded tops of the neural spines which are marked on the upper surface by a rugose pitted area; by the intercentra with more or less prominent processes for the heads of the ribs; and by having the ribs flattened and expanded distally and overlapping to form a protection for the thoracic cavity.

This family approaches the Otocœlidæ (now known to be a family of amphibians containing the genera *Dissorophus*, *Otocælus* and others), but differs in the fact that in the latter family the expanded spines are not rugose above and are overlain by a set of rugose plates, corresponding to the neural spines in number but distinct from them.

The new species, *A. glascoeki*, differs from *A. chiton* Broili in having the expanded apices of the neural spines much larger and marked with a coarser sculpture. The apices of the spines touch but do not overlap. The intercentra have prominent processes on the sides for the heads of the ribs.

In *A. chiton* there are facets a little more prominent than in *Eryops* and *Trimerorhachis*, while in *A. glascoki* they extend out from the sides of

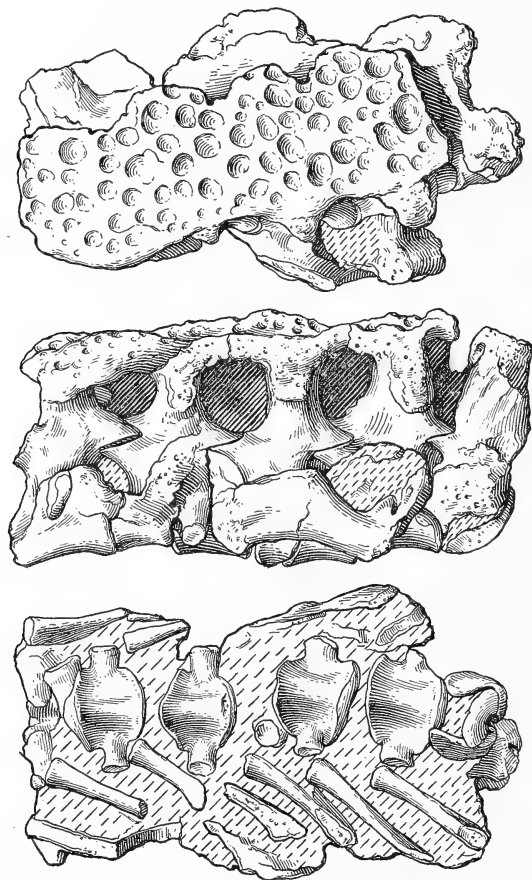


Fig. 9. *Aspidosaurus glascoki*, type vertebræ, No. 4864, A. M. N. H., superior, lateral and inferior aspects.  $\times \frac{2}{3}$  nat. size.

the intercentrum for two or three millimeters. The skull resembles that of *Trimerorhachis* as far as it is preserved. The animal was about 300 centimeters long.

***Tersomius texensis* gen. et sp. nov.**

Type: A small skull. No. 4719, Am. Mus. Nat. Hist. From a yellow clay near the upper layer of conglomerate, on the south side of the Little Wichita River, in Archer Co., Texas. Collection of 1906.



The skull is flattened, having nowhere near so much of an arch as in the specimen described by Cope as *Trimerorhachis conangulus*. The orbits are large, extending so close to the edge that there is a very thin maxillary border. The nares are small and look almost directly upward. The teeth are small and sharply conical with no enlarged ones visible in the maxillary or the mandible. The position and relations of the various bones is shown in the figures. There is no tabulare visible and it is probable that it was not present. Compared with *Trimerorhachis conangulus*, which it most closely resembles, there is no second prosquamosal (intertemporale) and the orbits are much larger and placed farther to the rear.

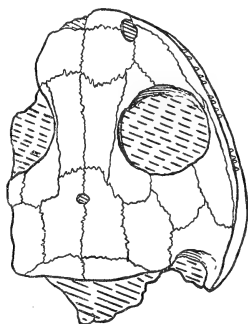


Fig. 10. *Tersomius texensis*, type skull, No. 4719, A. M. N. H.  $\times \frac{1}{2}$  nat. size.

#### Measurements.

	mm.
Length on the median line . . . . .	32.
Length of the lower jaw . . . . .	34.5.
Width at the back of the skull . . . . .	25.
Interorbital width . . . . .	7.

#### *Trimerorhachis alleni* sp. nov.

Type. Four dorsal vertebræ, No. 4577 Am. Mus. Nat. Hist., Cope Coll. From Texas.

This specimen differs from the type specimen in such important respects that it is necessary to regard it as a new species. The vertebræ are larger than any of the typical specimens, four intercentra occupying 166 mm. The neural spines show no indication of being divided, but the tops of the spines are still concave and show the former presence of a considerable mass of cartilage. The pleurocentra are proportionately very small. The spines are more erect and there are well formed posterior zygapophyses. The intercentra are marked on the lower face by deep pits lying on either side of a median keel. The posterior edges of the upper ends of the intercentra are reflected forward and form a concave facet.



Article XVIII.—THE SKELETON OF *PÆCILOSPONDYLUS*  
*FRANCISI*, A NEW GENUS AND SPECIES OF  
 PELYCOSAURIA.

By E. C. CASE.

This specimen, No. 4174, Am. Mus. Nat. Hist., Cope Coll., was collected by Mr. Charles H. Sternberg on Coffee Creek in Willbarger Co., Texas, in 1895. The elongate form of the body and skull with the general suggestions of Proterosaurian affinities fixes its position in the family Poliosauridæ. The character of the cervical vertebræ shows that it does not belong to the genus *Poliosaurus*; in form of body and evident adaptation it agrees pretty well with Broili's description of *Varanosaurus acutirostris*, but the character of the dorsal vertebræ shows that it belongs in a separate genus and species. Dr. Matthew has done considerable work upon this specimen and in this description I have availed myself of his kind permission to make use of his valuable notes.

Only the anterior portion of the skull is preserved and this is badly crushed. It shows the skull to have been elongate and slender with the small nares nearly terminal. The alveolar edge of the maxillary is nearly straight and there is no notch between the maxillary and premaxillary. The cheek teeth are slender, elongate cones of uniform size and there are no enlarged teeth on either the upper or lower jaw. The condition of the skull makes it impossible to go more into detail, the whole posterior half is gone and the bones of the facial region are indistinguishable. The lower jaws are separated at the symphysis and were probably only loosely attached during life.

There are twenty-seven vertebræ in the presacral portion of the column, two sacrals and thirty-two caudals. The presacral series is probably not quite complete; though there are several places in the series where there is no contact between the different pieces, the size and form of the vertebræ make such a continuous series that it is not likely that a great deal is missing. Beginning with the atlas there are eight in series, then a break and seven more in series, the posterior part of the column is broken into three pieces the last six presacrals being in series and attached to the sacrum. The caudal series is not so perfect and it is estimated that at least ten vertebræ are missing.

The *atlas* has the neural arch free and divided into halves. The anterior

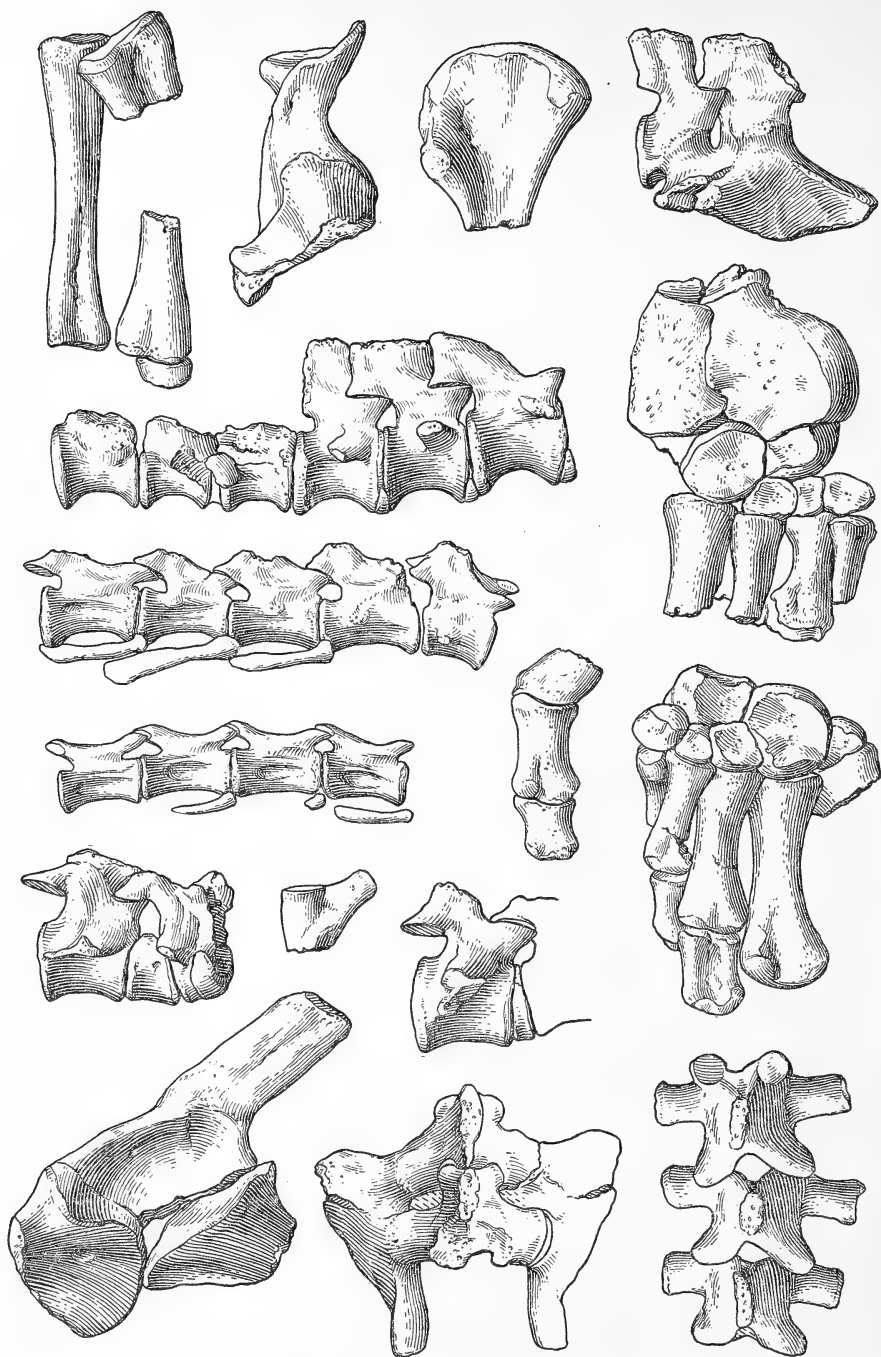


Fig. 1. *Pacilospondylus francisi*. Portions of the type, No. 4174, A. M. N. H.

*Top row:* Left (?) radius, ulna and ulnare, inner surface of left ilium with sacral rib attached, upper end of right humerus, sacral vertebrae. *Second row:* Presacral vertebrae 1-6, right tarsus, upper surface showing (from right to left) tibiale, fibulare, centrale 1, centrale 2 + tarsale 4, tarsale 1, 2, 3, metatarsals 1-4. *Third row:* Caudals 9-13. *Fourth row:* Caudals 23-26, two phalanges, left tarsus, upper surface showing (from left to right) centrale 1, centrale 2 + tarsale 4, tarsale 1-3, 5, and metatarsals 1-5. *Fifth row:* Atlas and axis, head of dorsal rib, fourth cervical. *Bottom row:* Left half of pelvis, top view of sacrum, top view of thoracic vertebrae, Nos. 6, 7, 8. All figures  $\frac{3}{4}$  nat. size.

zygapophyses are small and weak, the posterior are larger but much smaller than those of succeeding vertebrae. There is no neural spine but the upper surface of the posterior zygapophyses were elevated and prominent. The two halves of the neural arch are separated by the thin anterior end of the spine of the axis, which is thrust far forward between them as in the amphibians *Eryops* and *Acheloma*. A fragment just beneath the anterior zygapophysis of the left side indicates the possible presence of a proatlas.

The *axis* has a large spine which is very heavy posteriorly but extends anteriorly in a thin blade which is thrust in between the halves of the neural arch of the atlas. In this character the specimen differs markedly from *Poliosaurus* in which the anterior edge of the axis spine is heavy and thick and does not separate the halves of the neural arch of the atlas. The posterior pair of zygapophyses are of normal size; both pairs are located far up on the neural arch so that there is a considerable space between them and the prominent transverse processes. This constitutes another difference between *Pacilospondylus* and *Poliosaurus* for in the latter the transverse processes lie just below the zygapophyses. There is large intercentrum with a flat lower face between the axis and atlas.

In the posterior cervicals the neural arch begins to broaden out and the sides to become swollen; this process continues until in the mid-dorsal region the vertebrae resemble those of *Pareiasaurus*, *Captorhinus* and *Diadectes*. This condition of the vertebrae seems to be a primitive character as it is found also in *Telerpeton*, *Procolophon* and others of about the same period. The more slender cervical vertebrae seems to be a departure from the primitive type and an adaptation to the development of a long neck. Beyond the mid-dorsal region the neural arches become thinner again until on the first presacrals the sides are pinched in rather than swollen out and the whole aspect of the vertebral arch is changed. The neural spines of all the vertebrae posterior to the axis have been injured so that it is impossible to give an exact description, but it is altogether probable that they were as described by Broili, low and thin with about the same anterior posterior extent throughout the series.

In the fourth cervical the neural arch is not greatly widened and the centrum is elongate; the lower face of the centrum is entirely devoid of any keel and is much more slender and elongate than the corresponding bone in *Poliosaurus* which is wide and has a sharp keel on the lower surface. In the last mentioned genus the axis is much longer than the other cervicals, in *Pacilospondylus* it is about the same length. The transverse processes rise from the base of the neural arch and the faces of the zygapophyses are nearly horizontal.

Attached to the fifth vertebra is the head of a rib with distinct capitular

and tubercular faces but the two are not separated, being connected by a thin plate of bone.

On the *seventh vertebra* the neural arch has become broad and rounded, in great contrast to the thin pinched-in arches of *Poliosaurus*. The transverse process rises from the base of the zygapophysis and is supported by a thin buttress which runs downward and forward to the anterior edge of the centrum. The bottom of the centrum is narrowed but there is no keel.

The vertebræ from the *eighth* to the *seventeenth* are very similar to the seventh. The neural arches remain broad and rounded and the only apparent change is in the transverse process which becomes shorter and more slender. Fragments of an abdominal armor cling to the lower side of the twelfth to the seventeenth vertebræ; this is similar in character to that found in *Labidosaurus*, consisting of elongate scales arranged in an imbricate manner in the usual chevron pattern. Posterior to the seventeenth the vertebræ become more elongate and the arches more slender. The narrowed arches continue through the rest of the vertebræ to the sacrum, but the elongation quickly ceases; the greatest length is reached in the twentieth and twenty-first. From this point back the vertebræ shorten rapidly until in the twenty-seventh the first presacral is only 11 mm. as compared with 15 mm. of the mid-dorsal region. The shortening of the vertebræ is accompanied by an increasing concavity of the bottom line, but there is no keel. It is impossible to tell upon which vertebra the last free rib occurs, but the last seven, at least, had the ribs ankylosed to the transverse processes.

The *first sacral* is not more elongate than the last presacral. The neural arch is peculiar in being considerably wider anteriorly than posteriorly; this is largely due to the necessity for a support for the great transverse process and the sacral rib. The transverse process is very short and stout and the face for the rib looks largely downward. The *second sacral* is smaller than the first and the transverse processes do not widen the anterior portion; the rib is much smaller than the first. The vertebræ remain distinct, with well developed zygapophyses between them, there has been little or no progress toward the formation of a sacrum.

In the first *three caudals* the ribs are free and the neural arches much narrowed. The ribs have distinct tubercular and capitular portions but they are joined by a thin plate of bone as in the presacrals. The first series of caudals free from the sacrum begins with the fifth or sixth, the ribs are united with the transverse processes and there are well developed chevrons. The upper end of the chevron is perforated by a large foramen. The spine was pretty long, as an incomplete one measures 15 mm. while the length of the centrum is only 11 mm. Reckoning the first vertebra of the series as the fifth, there is a continuous series to the fourteenth; they show a gradual







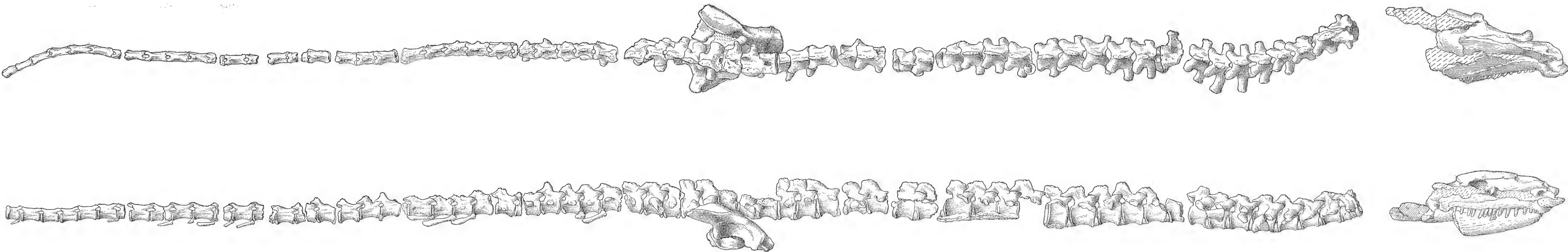
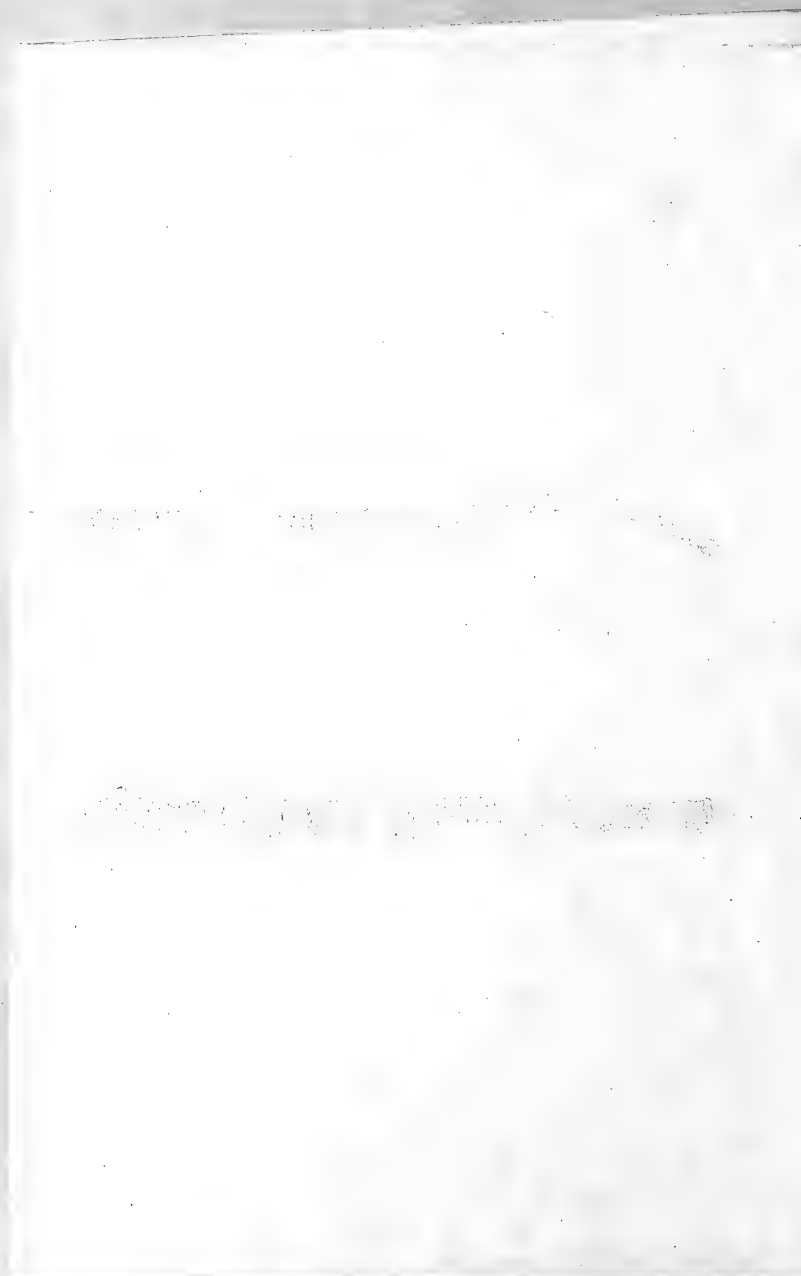


Fig. 2. *Pæcilospondylus francisi*, superior and lateral aspects of type.  $\times \frac{1}{3}$  nat. size.



shortening of the transverse processes and the ribs until on the thirteenth the last trace disappears; at the same time there is a very gradual increase in the length of the centrum which is first noticeable on the twelfth. At this point the caudals have definitely assumed the characters which go with a long and slender tail, the neural arches are low and elongate with the spines far back. There is a complete chevron, twenty-three mm. long, on the twelfth, while the length of the centrum is only fourteen and a half. The end of this chevron is expanded vertically and is very thin.

From the fourteenth to the thirty-second counted vertebra the series is broken and there are undoubtedly several missing, as well as some from the tip of the tail. The distal vertebræ become very long and thin and gradually lose the spines but retain some traces of the chevrons to the very last.

The *ribs* of the thoracic region are quite long and slender and are rounded in section. The first sacral rib has the distal end widely expanded and concave where it is applied to the inner face of the ilium. The distal end of the second sacral is smaller than that of the first and is partly applied to the posterior edge of the first and partly to the ilium.

The *shoulder girdle* is not preserved.

In the *pelvis* the ilium and the proximal ends of the ischium and pubis can be made out. The ilium has a strong crest sharply inclined to the rear, this is thickened and has a triangular section. It formed the major portion of the cotylus. The ischium and pubis are represented by the ends only, they are broad and plate like and it is probable that they lay horizontally as do the same bones in *Diadectes*, *Captorhinus*, etc.

The lower end of the *femur* only, is preserved; it shows that the whole bone was quite elongate and slender. There was no prominent ridge on the lower end such as occurs in the Pelycosaurs. The tibia and fibula, in keeping with the femur, are relatively long and slender. The *tibia* is only slightly curved and there is a shallow groove on the anterior face. The *fibula* is thin but the lower end is very wide and the bone is much more curved than is the tibia.

The *fore-limb* is represented by the proximal end of the humerus, the lower half of an ulna and a radius. The upper end of the humerus has a poorly defined articular surface and a strong but short deltoid ridge. The radius is nearly cylindrical.

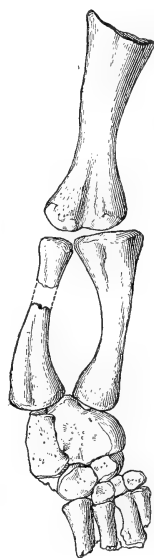


Fig. 3. *Pæcilospondylus francisi*, right hind limb of type, external, or dorsal view. (The tibial border is on the right.)

The *tarsus* is represented by parts from both sides. The astragalus and calcaneum with two bones of the distal row are preserved in one piece, from the right side, and three distal tarsals and four metatarsals in another. Six tarsals and metatarsals of the left side are in a third piece. The astragalus is of the form common among the Permian reptiles: there is a flat inner face with a notch which, with a similar notch on the inner face of the calcaneum, forms a foramen through the tarsus. The outer face of the astragalus is broad with a thickened process on the lower corner. The calcaneum is a flat disc-like element with a thick inner edge and a notch to unite with that of the astragalus. In the median row there is a slender element, elongate horizontally, lying beneath the union of the astragalus and the calcaneum, a smaller one beneath the astragalus and another outside the median element on the calcaneal side. The large median element articulates directly with the fourth and fifth metatarsals. Below the small element on the astragalus side there are three small elements supporting the first, second and third metatarsals. The fifth metatarsal is represented by the proximal end only but this shows it to have been of considerable size. The fifth was probably as large as the fourth, the third, first and second are progressively smaller. One fragment shows three phalanges, they are fairly long but proportionately wide and thin. The terminal phalanx is missing.

The *carpus* is not represented.

*Measurements.*

	mm.
Length of the specimen as laid out . . . . .	980.
Add for the skull about . . . . .	200.
Add for 10(?) missing caudals about . . . . .	170.
Total length . . . . .	1350.
Length of tail . . . . .	480.
Length of femur . . . . .	86.5
Length of tibia . . . . .	70.
Lower jaw incomplete . . . . .	109.5.
Length of tarsus with longest metatarsal . . . . .	79.
Longest metatarsal . . . . .	55.5.
Length of radius . . . . .	54.

Article XIX.—DESCRIPTION OF A SKELETON OF  
*DIMETRODON INCISIVUS* COPE.

By E. C. CASE.

PLATES XV–XIX.

This specimen, No. 4636, Am. Mus. Nat. Hist., was found by the author in 1906, in the red clay on the south side of Godlin Creek in Archer Co., Texas. It consists of a skull and lower jaws, the vertebral column complete as far as the seventh caudal, the pelvis, femur, tibia and fibula of the right side and most of the ribs. The vertebral column was in position, while the pelvis, limb bones, ribs and skull were separated. The skull, as is common in the fossils of the genus, was broken in the median line and the right and left halves were somewhat separated. The condition of the bones and the careful work of the preparator, Mr. Hermann, has made it possible to restore the skull and vertebral column in proper position and practically free from distortion. This is one of the rare occasions where a fossil has been discovered in the Texas beds not distorted and with the bones in position. The happy chance which has preserved the skull so perfectly makes it especially valuable as it is possible to give the proportions and shape very exactly and to add several new points in the morphology.

As previously shown by the author,<sup>1</sup> the skull is very high in the facial region, with narrow, flat frontal and parietal regions and the posterior surface falling off very steeply but not vertically. In general the bones of the skull are as already described and figured.<sup>2</sup>

The bones of the brain case have been crushed somewhat to the left and the paroccipital slightly displaced; flat facets on the lower part of the squamosals (postparietals, suggested by Broom) indicate where they were normally attached.

A separate element homologous with that described by Cope and Case as a *stapes* in *Theropleura retroversa* is considered as the stapes of *Dimetrodon*. Dr. Broom, from analogy with elements of similar position in the

<sup>1</sup> Publication 55, Carnegie Institution, Washington, 1907.

<sup>2</sup> In working on this specimen I was so fortunate as to have the opportunity to go over the material with Dr. R. Broom, the able authority on the Permian reptiles of South Africa, and a perfect agreement was reached as to the position and relations of the bones; differences remained in one or two instances as to the proper names and homologies of certain elements, as noted in the text.

South African forms, would call this a tympanic, an element reaching from the exoccipital to the quadrate and leaving above it an opening in which he would expect to find the distal end of a stapes. He would regard the bones identified as stapes in *Labidosaurus* and *Naosaurus* (*Edaphosaurus*) as the tympanic also.

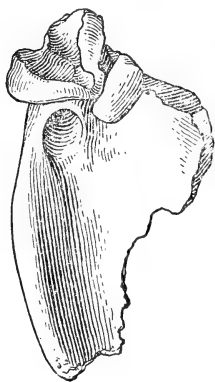


Fig. 1. Stapes of *Dimetrodon incisivus*.  $\times \frac{2}{3}$  nat. size.

The *basisphenoid* has, on each side, descending from the outer edge of the lower surface, a flange-like process with an articular face on the outer surface. It is to this that the head of the stapes was applied, with the outer end fitting against the inner side of the quadrate. In form the stapes resembles the expanded wing of a bird. The proximal end, corresponding to the base of the wing, is divided by a deep groove into a circular face, which is applied

to the face on the basisphenoid, and an elongate face on the portion of the still thickened edge which lies below and behind the circular face. Just below the circular face the bone is pierced obliquely by a large foramen. The main portion of the bone is expanded and proportionately thinner, the anterior edge is convex forward and rather heavy; the tip is broken off so that it is impossible to give the exact length, but it evidently reached nearly to the posterior edge of the quadrate. It seems to have been applied to the quadrate for a considerable portion of its length.

The *quadrate* extends far forward and is overlapped for a considerable distance by the pterygoid which lies on its inner side.

The position and relations of the *pterygoid* are shown to be different from previous interpretations in one or two important points. The strong external process, with its single row of teeth in sockets on the lower surface is placed obliquely to the jaw instead of horizontally; the flat outer faces are not on a plane with the side of the face but are inclined inwards, correspondingly the lower, tooth bearing edge, which is at a right angle to the outer face, is inclined upward and inward. The lower edges of the processes are thus inclined toward each other forming a space like an inverted V instead of being on a level.

In most reptiles the basiptyergoid processes of the basisphenoid are applied to the pterygoid near the middle point and opposite the inner end of the external process of the pterygoid when such a process is present. In *Dimetrodon* the basisphenoid is short and the middle point of the pterygoids far in advance, so there is a considerable interval between them. Well back

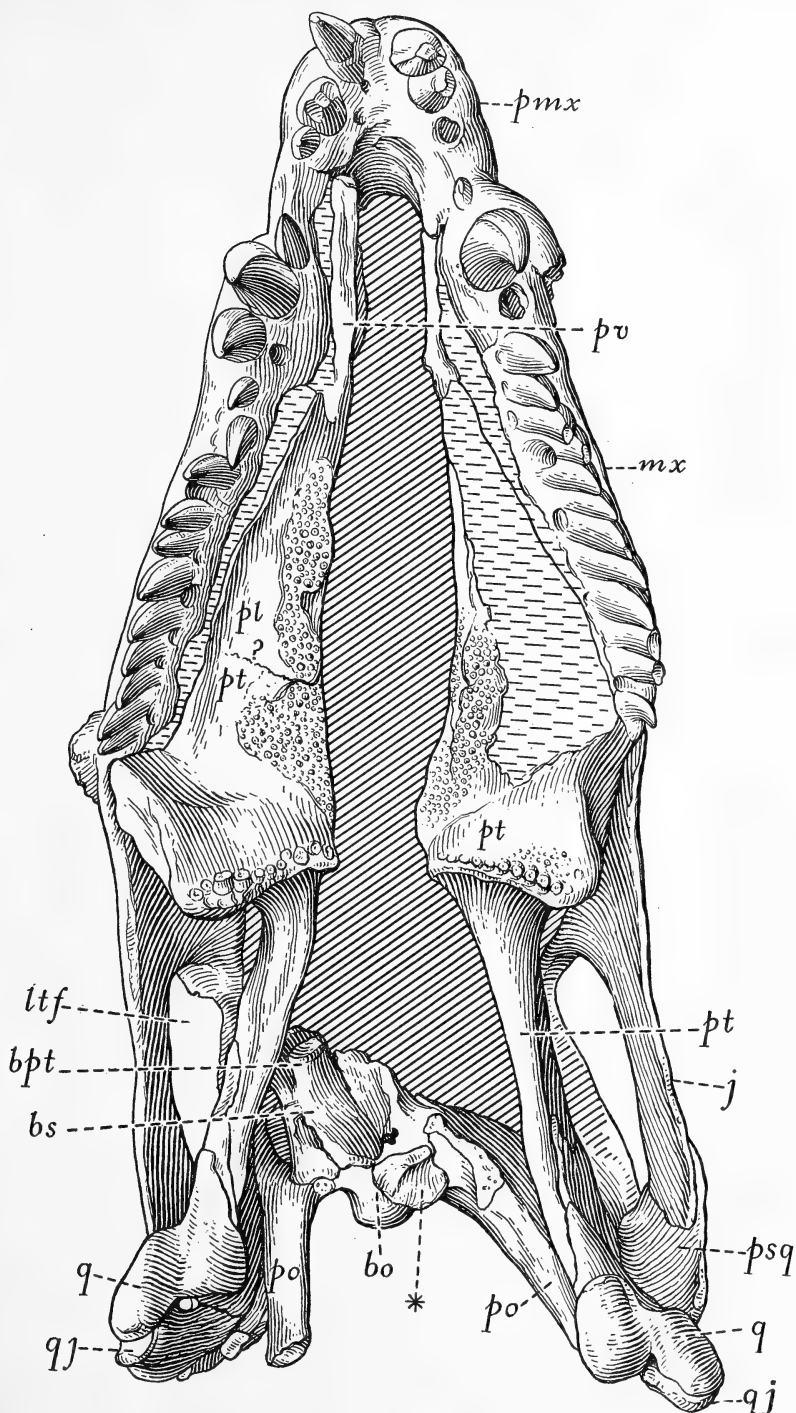


Fig. 2. *Dimetrodon incisivus*, inferior aspect of skull, slightly less than one half natural size. \* facet on basisphenoid for head of stapes, *bpt*; basipterygoid process; *lt. f.*, lateral temporal fenestra.

of the external process, the slender *epipterygoids* are applied to the inner side of the pterygoid, not resting upon them as is usual; the lower end is heavier and broader and is fitted into a shallow groove on the pterygoid; in this thick lower end there is a flat facet which articulated with the basiptyergoid process of the basisphenoid. This condition is very peculiar, for in the Cotylosauria,<sup>1</sup> Rhyncocephalia (*Sphenodon*), most Lacertilia and Dinosaurs, as *Allosaurus* and *Tyrannosaurus*, the basisphenoid articulates directly with the pterygoid at or near a point opposite the external process. Above the pterygoid the epipterygoid is very slender and its upper end is in contact with the lower surface of the postorbital.

Anterior to the external process the pterygoids are flat, horizontal

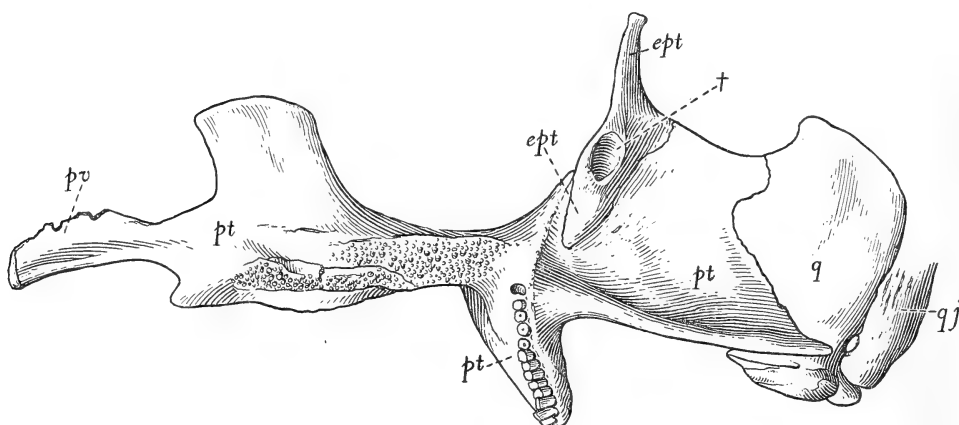


Fig. 3. *Dimetrodon incisivus*. Inner view of pterigoquadrate region with the bones nearly in the natural vertical position.  $\times \frac{1}{3}$  nat. size. † facet for basiptyergoid process. The portion of the pterygoid below the letters *pt* is horizontal; the part above rises vertically from the inner edge of the horizontal portion.

plates; these approach in the median line but are separated by a considerable interval. From the inner edges of the pterygoids rise vertical plates which are well shown on the left side. These rise very gradually from the posterior end but at about the middle of the anterior part of the pterygoid they rise very abruptly to the full height. The posterior edge of the vertical plate is concave forward and the whole plate is of little anteroposterior extent. Previous description<sup>2</sup> shows that these plates united anteriorly or were very closely pressed together and that they were in contact with the prevomers

<sup>1</sup> In *Diadectes* there is a bone seemingly overlying the pterygoid posteriorly, its limits are uncertain and it may be a part of the pterygoid but if it is an epipterygoid appearing on the under surface of the pterygoid it would have the same relations as in *Dimetrodon*, for the basisphenoid articulates with it.

<sup>2</sup> Carnegie Publication 55, p. 104.



below, anterior to the pterygoids. Two small fragments of bone which can not be placed in the skull are probably the anterior ends of these plates or of the prevomers and fitted close against the lower side of the premaxillaries. The vertical plates of the pterygoids and the ethmoid formed the median septum of the skull.

The *temporal region* is as described previously, except that there is in this specimen no supratemporal opening. This seems to have been a variable character in *Dimetrodon*. Some skulls show a definite elongate opening of good size (1002 Univ. of Chicago), others show an indefinite opening and the bones with very thin edges (1001 Univ. of Chicago), in others the opening

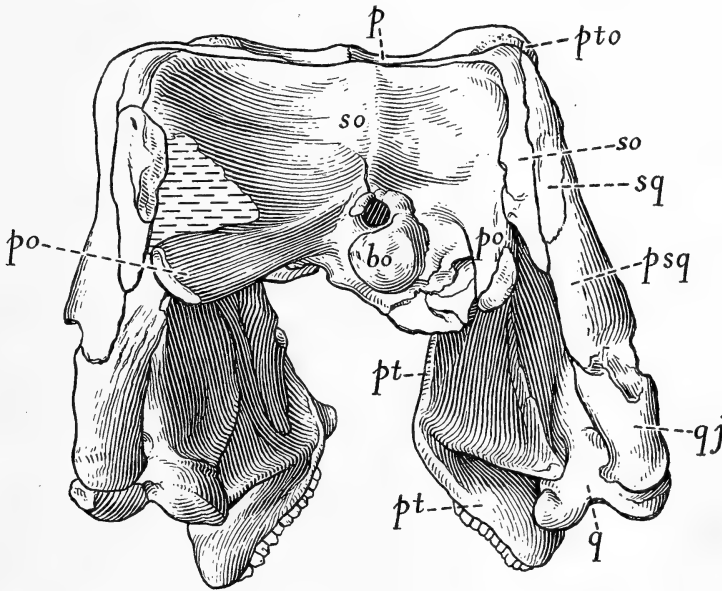


Fig. 4. *Dimetrodon incisurus*, posterior aspect of skull. Slightly less than one half natural size.

seems to be closed completely. In this specimen there is an opening at the proper place but it has every appearance of being due to the displacement of the bones due to crushing. The attachment of the bones was weak at best; an opening was either imminent or just disappearing.

The *axial skeleton* offers little new. The exact number of presacral vertebrae is shown to be twenty-seven. The spines of the third to the seventh vertebrae are cupped at the distal end showing cartilaginous attachment.

The anterior cervical *ribs* are double headed with large capitulum and tuberculum, the separation of these gradually decreases until on the four-

teenth, the separation between the two is no longer distinct and the whole head of the rib is in contact with the vertebræ. The last free rib is attached to the twenty-third or twenty-fourth vertebra, after this the ribs are fused with the transverse processes.

### Discussion of the skull.

The condition of the temporal region in the skull suggests several important considerations.

In such forms as *Captorhinus* and *Labidosaurus* the roof of the skull is formed posteriorly by the parietals, frontals, postfrontals, postorbitals and two lateral elements, an upper, squamosal, and a lower, prosquamosal or quadratojugal. On the posterior surface there are three: a small pair, the tabulare ("epiotic," this name should be abandoned as it suggests a connection with the otic region which does not exist), a pair of median plates, the supraoccipitals, and an outer pair uniting with the supraoccipitals above, the squamosals, quadrates, prosquamosals in front, and the paroccipitals

behind. This last pair has been referred to by me in a previous description of *Dimetrodon* as the quadratojugals, because of its relation to the quadrate and because there is a quadrate foramen separating it from the quadrate.

Dr. Williston has objected to calling this element the quadratojugal because of its relations to the paroccipital. In *Dimetrodon* the

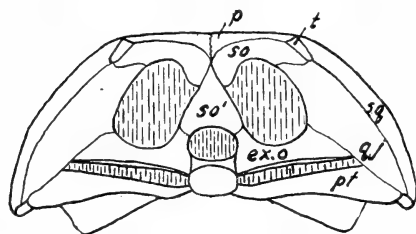


Fig. 5. *Captorhinus angusticeps*. Posterior aspect of skull of No. 4457, A. M. N. H.

condition is as shown in the figure and as previously described. The designation prosquamosal and quadratojugal being retained provisionally for the moment, it will be seen that the bones have essentially the same position as in *Captorhinus* and *Labidosaurus* with the exception of the lost tabulare. The supraoccipitals (not the dermal supraoccipital plates) have united with the exoccipitals and paroccipitals to form a posterior plate. The squamosals lie behind the lower process of the parietals and unite with a lower pair of elements exactly as in *Captorhinus*. Dr. Broom suggests that these are postparietals, homologizing them with the elements here called supraoccipital plates in *Captorhinus*, and would call the element here called prosquamosal, the squamosal. It seems to me much more probable that they are squamosals. The close relation of the primitive reptilia of the Texas Permian or Carboniferous to the higher amphibia warrants homologizing

the posterior plates with the supraoccipital plates of the Stegocephalia rather than with postparietals, elements which occur in the African forms of undoubtedly higher position and which have never been definitely determined in the American forms. With the development of the supraoccipital bone distinct from the supraoccipital dermal plates of the Stegocephalia and such forms as *Captorhinus*, the need for such plates would disappear and they would disappear with the need. This would leave the squamosals as the posterior lateral elements having the relations seen in *Dimetrodon* and I am disposed to retain the name.

With regard to the inferior pair of posterior elements there is perfect agreement among Drs. Broom, Williston and myself regarding their identity and relations. Now as to the proper name. It has been called quadratojugal by me because it lies outside of the quadrate, articulating with its posterior edge and is in part separated by a foramen, the quadrate foramen. It is true that this foramen carries no blood vessels or nerves but it is as persistent as the temporal fenestræ, which carry no vessels or nerves, and is entitled to as much weight in any natural classification. In the Dinosaurs, *Allosaurus* and *Creosaurus* there is a similar element which is only partly separated from the squamosal above, the suture runs part way between the bones and then disappears. In the Dinosaur *Tyrannosaurus* the suture and separation are complete. The relation of the element to the quadrate is exactly as in *Dimetrodon*. In all of these forms the paroccipital comes in contact with this element and in *Tyrannosaurus* with the parietal as well. So the condition in *Captorhinus* and *Labidosaurus* is not unique.

There is no inherent improbability that the element connecting the quadrate with the jugal is the prosquamosal (supratemporal), indeed if the arguments offered above have weight it must be so by exclusion. Other facts, however, may be cited in favor of this idea. The temporal region in the Stegocephalia is covered by the parietal, squamosal, prosquamosal, quadratojugal, and jugal. The prosquamosal is commonly the largest element of the temporal region; it articulates with the postorbital anteriorly, with the jugal below, and in many forms, as *Branchiosaurus*, etc., posteriorly, with the quadratojugal; it overlies the quadrate. The quadratojugal lies on the outer side of the quadrate and frequently extends up behind it; the portion which extends up behind the quadrate articulates with the posterior edge of the prosquamosal. This is exactly the relation of the outer pair of posterior elements in *Captorhinus* and the Pelycosauria.

If we assume that this element covering the posterior and outer surface of the quadrate in *Captorhinus*, *Diadectes* and the Pelycosauria, and separated from the quadrate by a foramen in the last two, is the quadratojugal, then we have in the temporal region the full number of bones of the Stego-

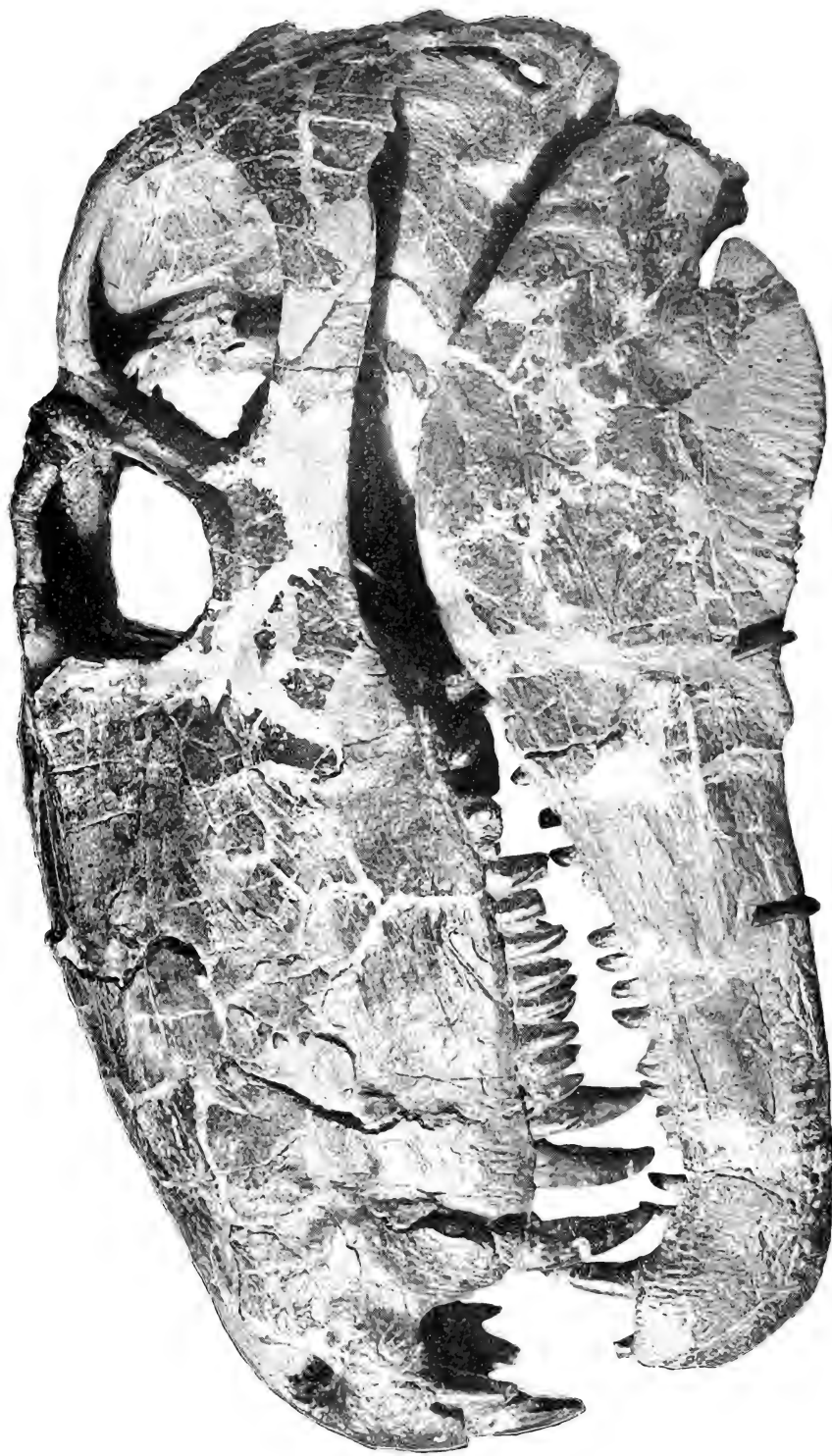
cephalian skull, and this bone is, in many forms, where it articulates directly with the jugal (Rhyncocephalia, Theropodous Dinosaurs and Phytosaurs) unhesitatingly called the quadratojugal. If, on the other hand, we assume this bone to be a new element and the bone anterior to it in Pelycosaurs and Cotylosaurs to be the quadratojugal, the skulls are radically different from the Stegocephalian skulls, having one more element on the posterior surface of the skull, and one less in the temporal region.

The condition of the Pelycosaurian skull gives a hint as to the condition of the skull of *Sphenodon*. Baur claimed that in *Sphenodon* the squamosal and prosquamosal had united in a single element, but Swinnerton and Howse found no trace of any division of this element in even the youngest embryos. Is it not just as probable that the prosquamosal dropped down to the lower edge of the skull and formed the connecting link between the jugal and quadratojugal as that it rose and fused with the squamosal? In *Palaeohatteria* the jugal joins the quadrate directly<sup>1</sup> but the squamosal (prosquamosal?) projects down nearly between them. The quadratojugal, if present, was on the back of the skull. As the Cotylosauria can no longer be considered as the primitive reptilian type, and, as the Rhyncocephalia can no longer be considered as derived from them by the simple development of temporal openings, the necessity of finding a prosquamosal bone in the skull of the Rhyncocephalia has passed.

The more definitely the anatomy of the primitive reptiles is known the more apparent it becomes that the theory which places the Rhyncocephalia as a central type directly derived from the Cotylosauria and giving rise to two main branches of Reptilia is inadequate and must undergo a serious reëxamination.

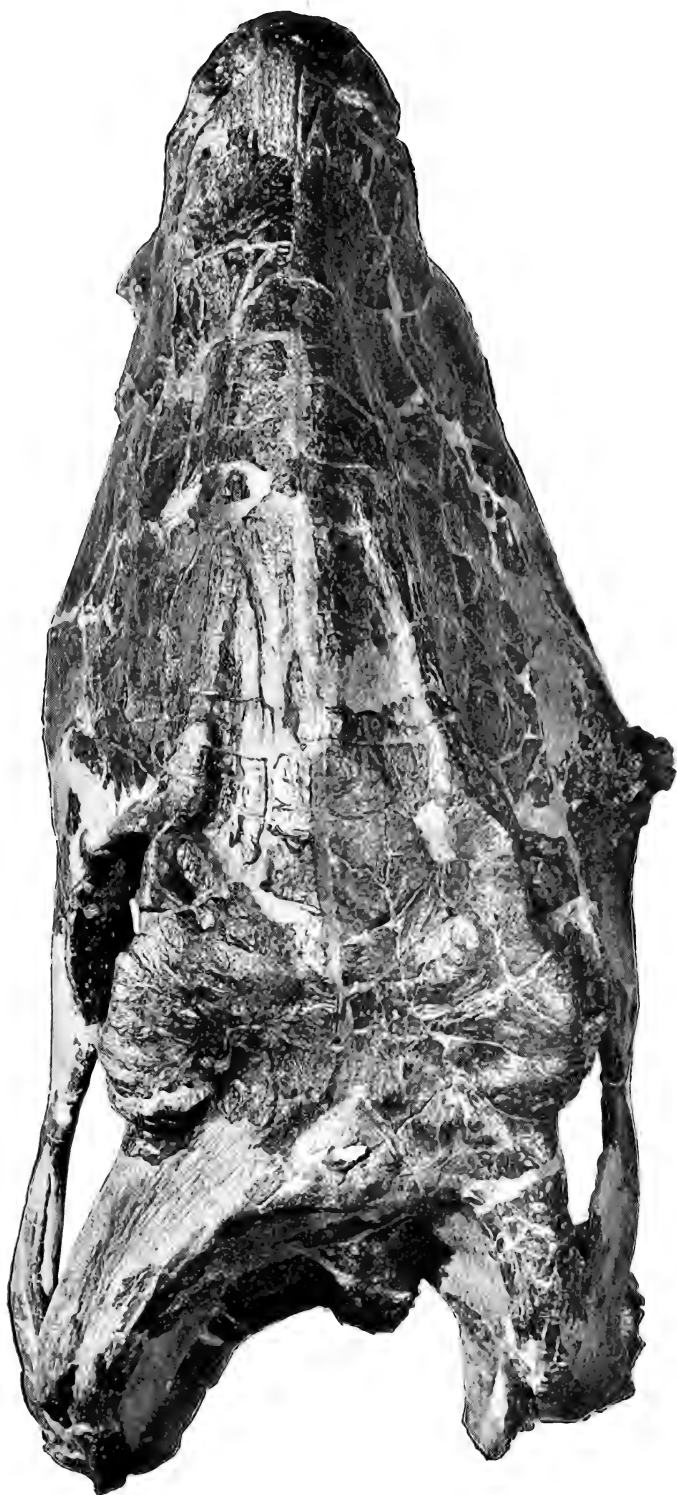
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<sup>1</sup>Credner Zeitsch. d. Deutsch. Geol. Gesell., Jahrg. 1888, s. 546.



*Dimetrodon incisivus*. Lateral aspect of skull, No. 4636 A. M. N. H. Slightly less than  $\frac{1}{2}$  natural size.

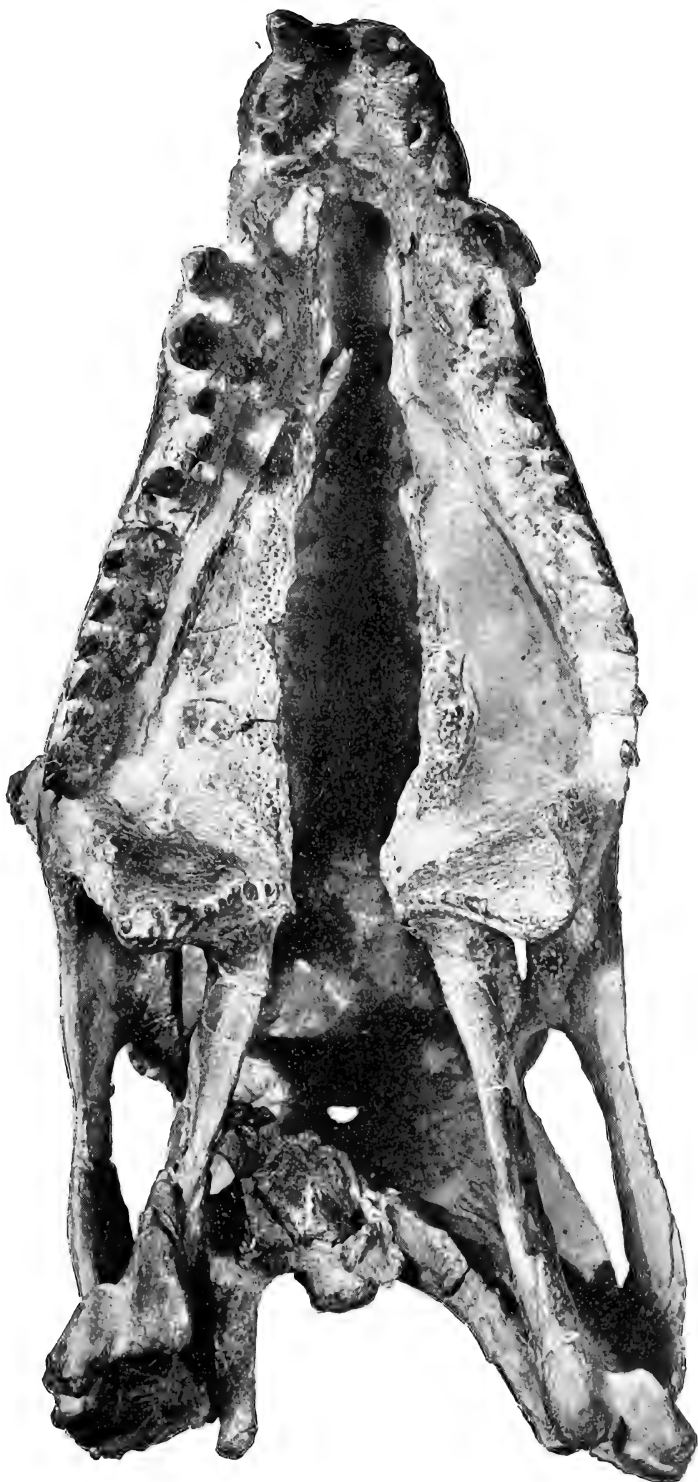




*Dimetrodon incisivus*. Superior aspect. Less than  $\frac{1}{2}$  nat. size.







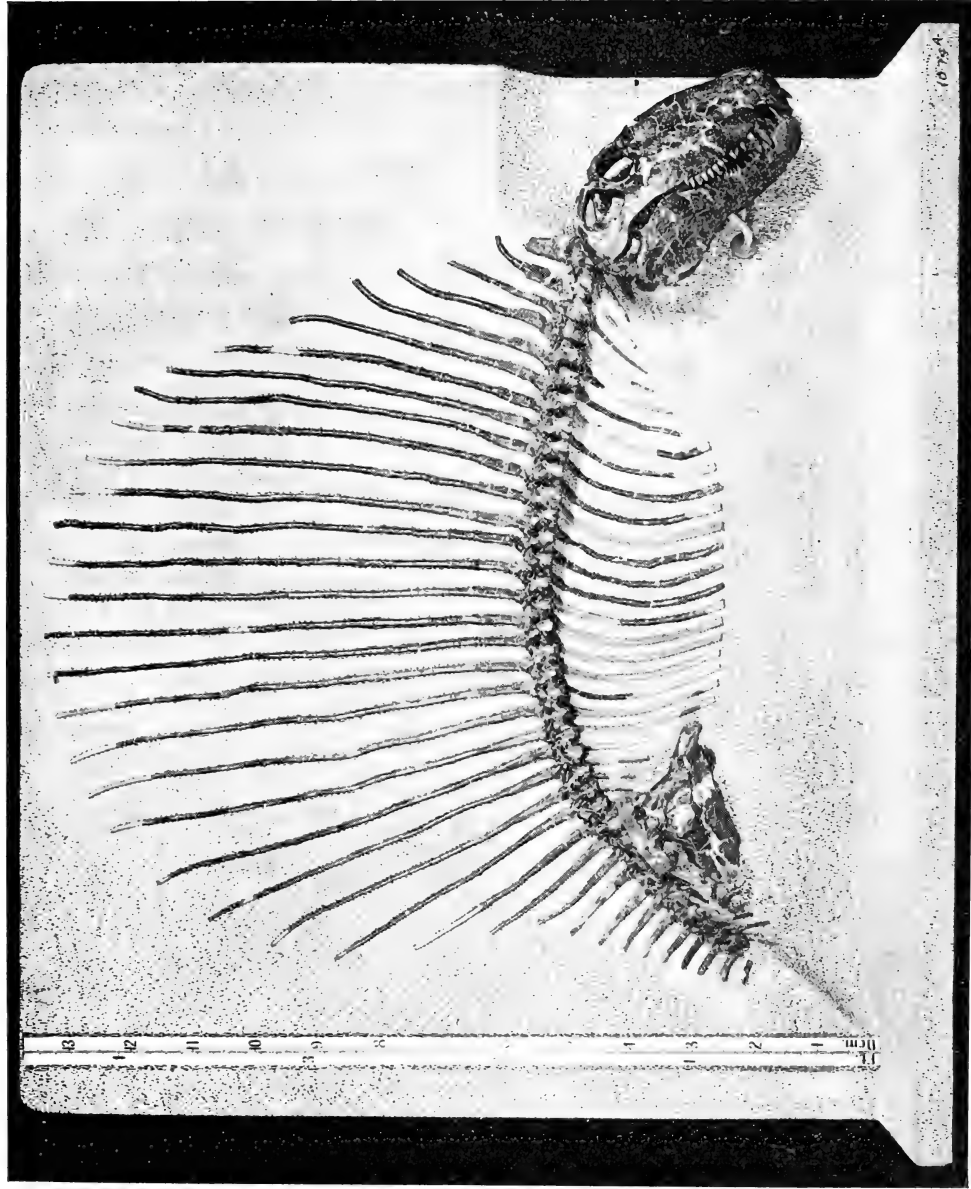
*Dimetrodon incisivus*. Inferior aspect of skull. Less than  $\frac{1}{2}$  nat. size.



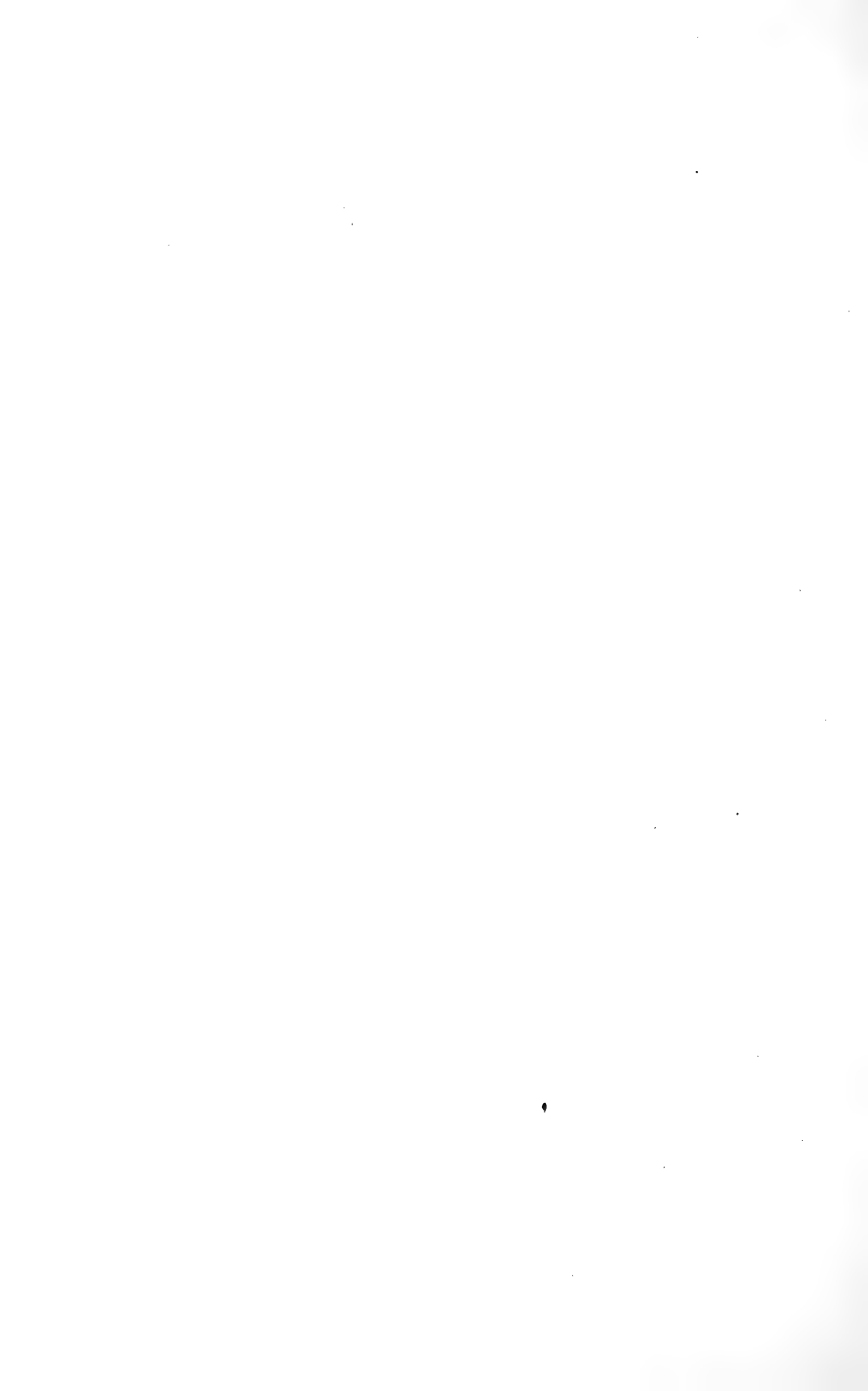


*Dimetrodon incisus*. Posterior and anterior aspects of skull. Less than  $\frac{1}{2}$  nat. size.





*Dimetrodon incisivus*, mounted skeleton, No. 4636 A. M. N. H. Mounted by A. Hermann. Greatly reduced.  
Scale in feet and decimetres.



**Article XX.**—A COMPARISON OF THE PERMIAN REPTILES OF  
NORTH AMERICA WITH THOSE OF SOUTH AFRICA.

BY R. BROOM, M.D., D.Sc.

Victoria College, Stellenbosch, S. Africa.

*Historical — South African Permian Reptiles.*

The first discovery of fossil reptiles in South Africa was made by A. G. Bain in 1838, when he found the large skull which in 1876 became the type of *Pareiasaurus serridens*. Bain, who is regarded as the Father of South African geology not only gave the first detailed account of the South African formations — an account which the latest work has proved to be surprisingly accurate — but it is to him that the discovery of most of the Karroo fossil reptiles in the British Museum is due. Almost all his specimens he sent to Owen by whom they were ultimately described and the indebtedness of Science to Bain has been fully acknowledged.

To Owen is thus due almost all that has been known of South African Permian forms till comparatively recent times. In 1845 he described two species of *Dicynodon*, and in 1855 another species. In 1859 he founded the order Anomodontia for the reptiles with an anomalous dentition, including under it the “families” Dicynodontia for *Dicynodon*, Cryptodontia for *Oudenodon* and Gnathodontia for *Rhynchosaurus*. In 1860 he described two reptiles with a mammal-like dentition, viz: *Galesaurus* and *Cynochampsia*, and in the same year three species of *Oudenodon* and two of *Ptychognathus*. The following year he added the “family” Cynodontia to the Anomodontia for the reception of *Galesaurus* and *Cynochampsia*. In 1876 Owen published his large catalogue of the South African fossil reptiles in the British Museum which is the most important work that has appeared on the Karroo reptiles. He gives descriptions of *Pareiasaurus* and *Procolophon*, of *Tapinocephalus*, and of the imperfect skulls of a large number of mammal-like reptiles. Among the Anomodonts in addition to a large number of new species of *Dicynodon*, *Oudenodon* and *Ptychognathus*, he describes the new genera *Endothiodon* and *Cistecephalus*. In one or two respects later work has shown that his classification is unsatisfactory. Thus *Tapinocephalus* and *Pareiasaurus* he regards as types of two new “families” of the Dinosauria, while all the reptiles with mammal-like dentition are grouped together under the new order Theriodontia. *Procolophon* is also included in the Theriodontia, and

*Saurosternon* is placed with the Labyrinthodonts. Notwithstanding these defects almost all subsequent work has been merely a further building on the foundation laid by Owen.

Seeley came out to South Africa in 1889 and obtained, principally through Mr. T. Bain, Dr. Kannemeyer, and Mr. A. Brown a fairly large collection of fossil reptiles. Most of these and a number of specimens belonging to the South African and Albany Museums were described by him between 1889 and 1895. His most important work on the Permian reptiles is a description of a fairly good skeleton of *Pareiasaurus*. He described *Delphinognathus* from a skull in the South African Museum and founded for it the suborder Dinocephalia. He contributed a good deal to our knowledge of the Anomodont skeleton and described a number of new genera, including *Eunotosaurus*, *Cryptocynodon* and *Pristerognathus*. The most important part of Seeley's work, however, deals with the Upper Triassic types such as *Cynognathus* and *Gomphognathus*. He suggested various new classifications but these have not been generally accepted.

In any historical sketch of the South African reptiles must be mentioned the name of Lydekker, who in 1890 published a new catalogue of the specimens in the British Museum. He described very few new forms, and was more impressed by resemblances than differences. His revision of Owen's types has led to the elimination of a considerable number of doubtful species and to a clearer understanding of the early types.

During the last ten years I have been enabled to throw some further light on the structure of the Permian reptiles and have described a considerable number of new forms. As regards classification, I have thought it well to retain the name "Anomodontia" for the *Dicynodon*-like forms, as originally intended by Owen, and it has been found necessary to divide Owen's Theriodontia into two, as the Permian forms have among other characters a Rhynchocephalian palate, while the Triassic forms have a secondary palate like mammals. For the earlier group I have proposed the name "Therocephalia," and for the latter group Owen's name of 1861 "Cynodontia" should be retained. The name "Theriodontia" becomes unnecessary and should be dropped. The various orders or suborders of mammal-like reptiles — Dromasauria for *Galechirus*, Dinocephalia for *Delphinognathus*, etc., Therocephalia for *Scylacosaurus*, etc., Anomodontia for *Dicynodon*, etc., and Cynodontia for *Galesaurus*, etc.— I have proposed to group under a single superorder or order, the "Therapsida."



*Historical — American Permian Reptiles.*

Our knowledge of the American Permian reptiles is mainly due to Cope, who first described them, and who between 1878 and 1894 published many papers dealing with the structure, affinities and classification of the groups. Case, in his recent memoir on the Pelycosauria gives a full historical account of Cope's work, and of the frequent modifications of his opinions as his investigations proceeded. None of his numerous attempts at classification appear to have long satisfied even himself, and one can fully sympathise with his difficulties. When he first examined such types as *Clepsydrops*, *Dimetrodon*, *Diadectes*, and *Pariotichus*, he was apparently struck by the fact that while in many ways they seemed related to each other, they also showed affinities with the Rhynchocephalia on the one hand and the South African Theriodonts and Anomodonts on the other. In all his proposed classifications we see an endeavour to express these affinities, while at the same time differentiate the groups. The order Pelycosauria was primarily established for reptiles resembling *Clepsydrops* and *Dimetrodon*, but for a time genera such as *Pariotichus* and *Diadectes*, and the South African Theriodonts, were also included in it. Later on *Diadectes* was placed in a new group, the Cotylosauria, which though temporarily abandoned was ultimately extended to include all the Permian reptiles with a roofed temporal region. Very early Cope was struck by what appeared to be the mammalian affinities of most of the Permian types and proposed the name Theromorpha, afterwards changed to Theromora, for all the mammal-like forms.

Between 1889 and 1897 Zittel, Lydekker, Seeley, and Haeckel supported the view that the order Pelycosauria was probably identical with the Theriodontia of Owen and allied to the Anomodontia, and the name "Theromorpha" or "Theromora" was very generally used to include almost all known Permian reptiles.

In 1897 Baur and Case believed they discovered in *Dimetrodon* two temporal arches, and argued that the Pelycosaurs were more nearly related to the Rhynchocephalians, and should be removed from association with the mammal-like Theriodonts and Anomodonts. Since then most writers, including Smith-Woodward, Hay, Zittel, Osborn, McGregor, Boulenger, Case, and Broom, have agreed in separating the Pelycosaurs from the South African type. A few however — Gadow, Broili, and v. Huene — still favour the older view.

In 1904 Broili published a most important account of the Permian reptiles of Texas. Besides giving descriptions of a number of new types he added much to our knowledge of the structure of others, especially *Labidosaurus*.

Case, in 1907, issued his 'Revision of the Pelycosauria of North America,' in which he critically re-examines all Cope's specimens and most of those more recently obtained. Besides giving a complete systematic revision of all the known genera and species, he deals at length with the structure and morphology of the different types. His figures of complete restorations of *Naosaurus* and *Dimetrodon* give a better idea of the general appearance of the Pelycosaurs than was previously possible.

#### SOUTH AFRICAN PERMIAN FAUNA.

Before comparing the North American and the African Permian faunas it will be necessary to examine in some detail the structure of the most typical and best known genera of each continent.

South Africa during the whole of Permian times was almost completely covered by a large fresh water lake or series of lakes or marshes. Enough is not yet known of the geology of the Karroo to say definitely what the conditions of deposit were, but the shales which are found over the greater part of the country were probably formed by the mud brought down by some huge river or rivers and deposited in a shallow lake. Irregular beds of sandstone are found throughout the whole formation, varying in thickness from a few inches to many feet. The sandstone beds often abruptly pass into shale, and they usually show signs of false bedding. Possibly the sand was wind-blown over the dry banks of mud during periods of drought. However the sandstone may have been formed it is interesting to note that reptilian remains are usually found in the shale immediately below a bed of sandstone and sometimes in the sandstone itself, but very rarely in the middle of a very thick bed of shale. Most probably the reptiles lived and died on the banks of the swamps or lagoons, and their bones became preserved in the mud and sand.

In Upper Carboniferous and Lower Permian times the climatic conditions were unfavourable for land animals and though the geological conditions were ideal for their preservation few land forms are met with till we reach beds which are probably Middle Permian. The first forms we find are two large imperfectly known Dinocephalians, one of which has been named *Archæosuchus*, and a huge Diaptosaurian, *Eccasaurus*. Other small animals are only known by fragmentary vertebræ and limb bones. In the north of the colony, on a horizon which at present cannot be correlated with certainty with those of the southern Karroo but probably of Middle Permian age, we find remains of *Galechirus*, and *Galepus*, primitive Therapsidans, *Heleosaurus* and *Heleophilus*, two possibly semiaquatic Diaptosaurians, and a small species of *Oudenodon*.

In the south, at a horizon probably 2000 feet above that in which the Dinocephalians first appear, we begin for the first time to get an abundant fauna. *Pareiasaurus*, of which at least two species are known, is not uncommon. The gigantic *Tapinocephalus* and the smaller but allied *Delphinognathus*, the large imperfectly known *Titanosuchus* and the small *Gorgonops* represent the Dinocephalians. A few small species of *Dicynodon* and *Oudenodon* are met with, and a large number of rather small Therocephalians. From the same horizon only one Stegocephalian genus is known, *Rhinesuchus*.

In the Upper Permian beds the Anomodonts become abundant. Many species of *Dicynodon* and *Oudenodon* are found, some fairly large. Besides these, are many other Anomodonts which though unknown in the older beds are clearly of a more primitive type. These are included in the family Eudothiodontidæ and differ from *Dicynodon* and *Oudenodon* in having molar teeth. A considerable number of genera are known. Numerous Therocephalians are found in the Upper Permian beds, but their structure is imperfectly known. A small reptile, *Saurosternon*, is found which is now known to be allied to *Procolophon*. *Pareiasaurus* is no longer met with but two allied genera, *Propappus* and *Anthodon*, are known.

As in the present paper I only wish to show that the South African fauna is distinctly related to that of the Permian of North America I shall confine myself mainly to the consideration of the skulls of a number of the more important types and endeavour to show that the American types are in many ways singularly like those of the South.

#### *Pareiasaurus.*

Though four fairly good skeletons of *Pareiasaurus* have been discovered which reveal most of the general structure of the skeleton there are many details of which we are still ignorant.

The skull is large with the temporal fossæ completely roofed over, but the detailed structure of the roof is still doubtful. There appears, however, to be little doubt that there is a quadrato-jugal. The bones are pitted somewhat like those of Stegocephalians. There is a distinct septomaxillary. The palate is fairly well known and as shown in the figure (Fig. 1) has the typical structure met with in most primitive reptiles. There are paired prevomers bearing teeth, paired palatines probably also bearing teeth, and apparently small transpalatines. The pterygoids are fairly large and have rows of small teeth.

The occipital condyle is flat.

The vertebræ are large and massive and have intercentra. The zygophyses are very broad. The ribs for the most part are single-headed.

The shoulder girdle has a large scapula with a well developed acromion, large precoracoid and fairly large coracoid. There is well developed cleithrum, fairly large clavicles and a massive T-shaped interclavicle.

The humerus is very massive and has a large deltopectoral ridge. The ulna has an olecranon process.

The carpus, so far as known, appears to be similar to that of most early reptiles.

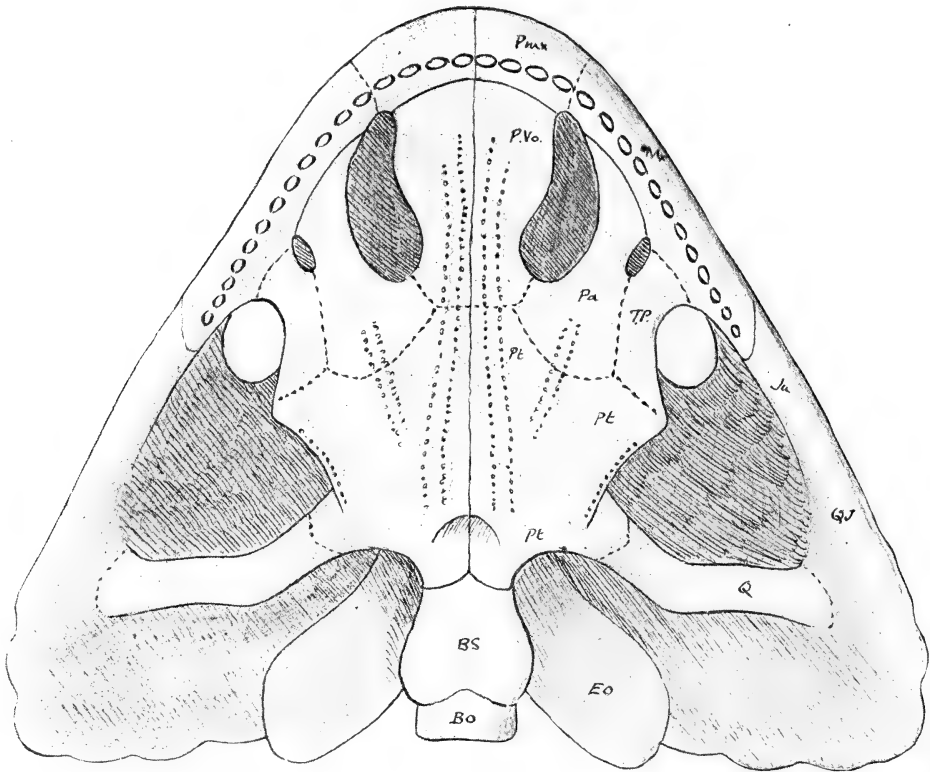


Fig. 1. Under view of skull of *Pareiasaurus*. Slightly restored.

The digital formula is unknown. It has been stated to be 2, 3, 3, 4, 3, but in the closely allied *Propappus* it is most probably 2, 3, 4, 5, 3, two digits having certainly more than 3 phalanges.

There are apparently no abdominal ribs.

The pelvis is remarkable for having the ilium large and directed forward as in Mammals and the higher Therapsida.

The teeth are peculiarly specialised. Externally they are markedly convex, the inner side being nearly flat. Round the edges are 7 or 9 large cusps arranged in a semicircle.

*Procolophon.*

*Procolophon* is a small lizard-like reptile with a large broad head and comparatively short limbs, which, though only known from the Middle Triassic beds of the Karroo, may be considered as a Permian type which has survived. *Saurosternon*, which undoubtedly occurred in Permian times, is apparently pretty closely allied, but is less perfectly known.

The skull, which forms the type in the British Museum, though very fine has been somewhat injured in preparation and much of the bone removed. This has resulted in two small lateral temporal vacuities having been artificially produced. In all specimens where the temporal region is perfectly preserved there are no vacuities. Though *Procolophon* has been somewhat specialised in one or two respects the skull shows most of the features that must have been present in the ancestral Diaptosaurian. The premaxillary and maxillary are well developed. There is a small septomaxillary. The nasals are large. There are distinct lachrymals, prefrontals, postfrontal and postorbitals. The squamosal is small and there is a large quadrato-jugal which in many skulls, probably males, forms a large lateral horn. There is a well developed superficial bone doubtless corresponding to the so called "epiotic" of the Stegocephalians but which had probably better be called posttemporal. The temporal roof is narrow owing to the very large size of the orbit, but it is interesting to note that it is formed by the very same bones as in *Sphenodon*, viz., squamosal, quadrato-jugal, jugal and postorbital, the chief difference being that in *Procolophon* the bones are close together, whereas in *Sphenodon* they are pushed apart by the development of two large temporal vacuities.

The palate is a modification of the Rhynchocephalian type. The premaxillaries have large palatine processes. The prevomers are large and have a number of teeth as shown in the figure (Fig. 2). The palatines are small and have a few teeth. The pterygoids do not extend so far forward as in the typical Rhynchocephaloids. They meet the prevomers in front and the quadrates behind. They bear a few teeth. There is a small but distinct transpalatine which with the pterygoid forms a well marked pterygoid process. There are feeble, very lizard-like epipterygoids. The parasphenoid (true vomer) is present but small. The occipital condyle is single and rounded.

There is a distinct proatlas; and the body of the atlas is already united to the axis to form an odontoid process. There are well developed intercentra, and both the cervical and dorsal ribs are single-headed.

The shoulder girdle has a short scapula, and well developed coracoid and precoracoid which remain distinct throughout life. There are no cleithra, but well developed clavicles and interclavicle.

The digital formula is 2, 3, 4, 5, 3-4.

The pelvis has plate-like pubis and ischium.

There are numerous small abdominal ribs.

There has been much discussion as to the systematic position of *Procolophon*, but if we recognize that on the one hand it comes near to the primitive Rhynchocephalians and on the other retains characters of the

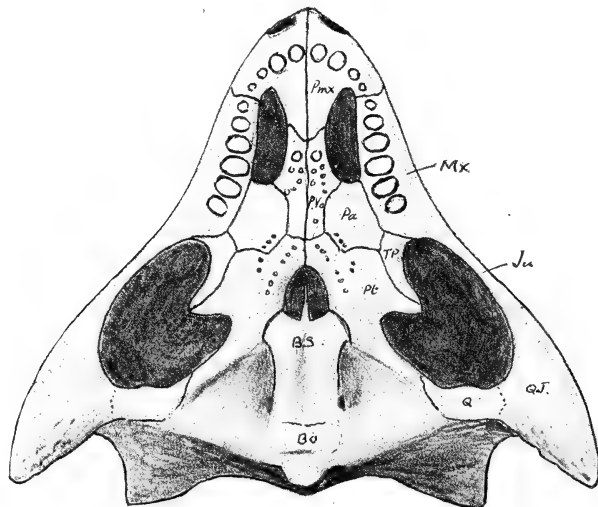


Fig. 2. Under view of skull of *Procolophon trigoniceps* Owen. Supposed male. Nat. size.

primitive roofed types it matters little with which division it is placed. It certainly seems to me nearer even to the living *Sphenodon* than it does to *Diadectes* or *Pareiasaurus*.

There are a number of other primitive Diaptosaurians or advanced Cotylosaurs in South Africa but they are imperfectly known. The best known are *Mesosaurus*, *Heleosaurus*, *Heleophilus*, and *Saurosternon*.

#### \**Dromasauria*.

This suborder was proposed by me for the small primitive mammal-like reptile *Galechirus*, which though essentially allied to the more typical Therocephalians shows a number of more primitive characters. Though most of the skeleton of *Galechirus* is known, unfortunately we know little of the skull. Just recently however, a new specimen has been discovered of an allied genus in which the skull is well preserved. This new animal I propose to call ***Galepus jouberti***. It is about the same size as *Galechirus scholtzi* but differs in a number of respects.

The skull is extremely interesting. In general shape the snout is somewhat lizard-like and the orbit is very large (Fig. 3). The temporal fossa is about half as large as the orbit. The parietal region is broad with a large pineal foramen. As in the Anomodonts, the postorbital meets the squamosal, and the squamosal is large and extends down by the side of the occiput a

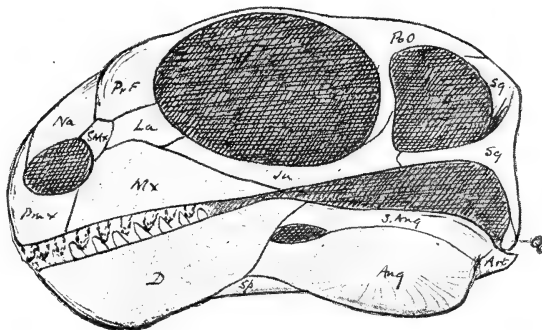


Fig. 3. Skull of *Galepus jouberti* Broom.  $\times \frac{5}{8}$ . Slightly restored.

considerable distance below the jugal arch. There is no quadrato-jugal. The lower jaw has the angular and surangular together as large as the dentary, and there is practically no coronoid process. The canines are not enlarged.

The shoulder girdle is of the ordinary Therapsidan type, but it is doubtful whether there is any cleithrum.

The digital formula is 2, 3, 3, 3, 3.

There are abdominal ribs in both *Galechirus* and *Galepus*.

In the possession of abdominal ribs, the simple plate-like pelvis, the generalised dentition and the separation of the maxilla from the nasal by the septomaxillary and the lachrymal, the Dromasauria are more primitive than any of the other Therapsida.

### *Dinocephalia.*

The order or suborder Dinocephalia was proposed by Seeley for reptiles of the type of *Delphinognathus* and *Tapinocephalus*, and though when it was proposed it was impossible to characterise it satisfactorily there is little doubt that these genera can very conveniently be placed in a distinct suborder. The other genera which seem to fall into the same group are *Titanosuchus*, *Scapanodon*, *Pelosuchus*, *Archæosuchus* and *Gorgonops*. It is possible that the Russian forms *Deuterosaurus* and *Rhopalodon* also belong to the *Dinocephalia* but at present they are only very imperfectly known.

In *Tapinocephalus* and *Delphinognathus* the skulls are fairly well known, and as they are closely allied, between them we have revealed most of the points of structure.

The bones of the upper cranial wall are enormously thickened and the pineal foramen is very large (Fig. 4). There is a single temporal fossa bounded by the squamosal, parietal, and postorbital. The squamosal is very large and the descending part passes so far forward as to carry the

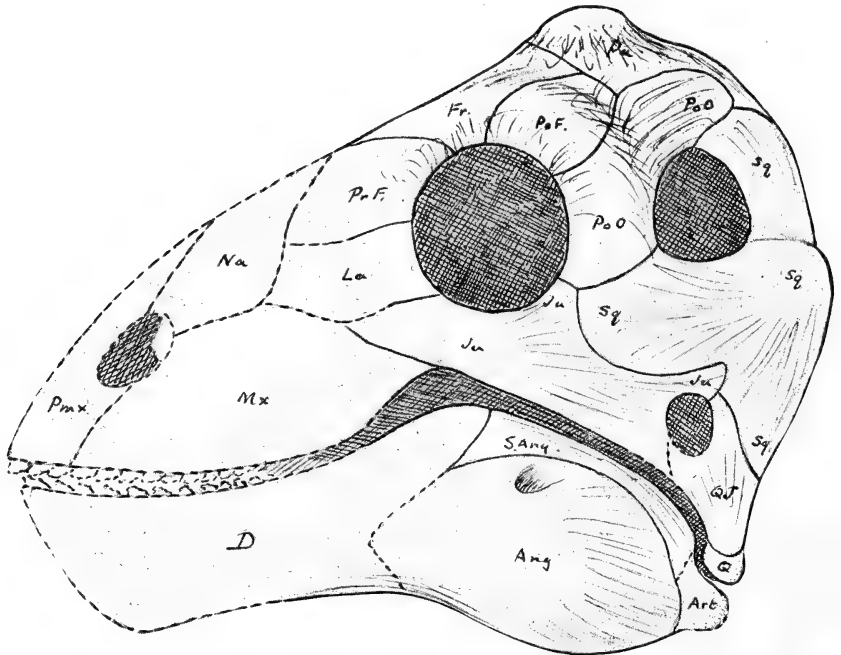


Fig. 4. Skull of *Delphinognathus conocephalus* Seeley. About  $\frac{1}{3}$  nat. size. Restored in front.

quadrate almost under the orbit. A well developed quadrato-jugal is present in *Delphinognathus*.

The palate is a little like that of *Procolophon* but differs in there being no teeth on any of the bones and in the absence of a transpalatine.

The occiput is very wide, the lateral portions being formed as in the Anomodontia by the squamosals. The condyle is single and rounded.

The lower jaw has a large angular and surangular and a very large articular which together form more of the jaw than the dentary. There is no distinct coronoid process formed by the dentary. The teeth are not, in *Delphinognathus* at least, differentiated into incisors, canines or molars; but



in *Titanosuchus*, *Gorgonops*, *Archæosuchus* and *Scapanodon* there are specialised canines.

The vertebrae are remarkable for the great development of the transverse processes which resemble those of the Pelycosaurs, the spines are, however, by no means unusually large.

The shoulder girdle has a large scapula, coracoid and precoracoid. There is a feeble cleithrum, powerful clavicles, and a large interclavicle.

There is no evidence of abdominal ribs.

### *Terocephalia.*

This suborder of the Therapsida was proposed by me in 1903 for those mammal-like reptiles which have differentiated incisors, canines, and molars, and a palate of the Rhynchocephalian type.

For long the Permian mammal-like forms with the open palate were grouped with the upper Triassic forms which have a secondary palate, under the name Theriodontia. When it was recognised that the Permian types differed greatly from the Triassic the name *Terocephalia* was proposed for the primitive group and, as had been previously done by Seeley, Owen's older name of *Cynodontia* was applied to the higher forms. This adoption of the name *Cynodontia* is all the more justifiable since the first animal described by Owen with mammal-like teeth was *Galesaurus*, which is a typical Triassic form.

Most of the early described *Terocephalians* were too imperfect to reveal much of the essential structure and even now little is known of the skeleton except the skull, and that is only fairly well known in four genera, *Scylacosaurus*, *Lycosuchus*, *Aloposaurus*, and *Scaloposaurus*.

*Scylacosaurus sclateri* is known by a nearly perfect skull, and by an imperfect one which, however, shows the palatal structure. In general proportions the skull is fox like (Fig. 5). The maxillary is large, the premaxillary rather small, and there is a distinct septomaxillary. The jugal arch is fairly strong. The frontals are long but narrow. There is a distinct post-frontal and a small postorbital. The pineal foramen is large, but relatively smaller than in the *Dinocephalia* or *Dromasauria*. The squamosal is large and the quadrate small. There is no quadrato-jugal.

The palate has a pair of very long prevomers without teeth, and a pair of large palatines, also without teeth. The pterygoids pass forward between the palatines to meet the prevomers. They have an external process which meets the transpalatine, and a posterior process which extends to the quadrate. There are a number of small teeth on the pterygoid. There is a well developed distinct transpalatine which stretches from the jugal and palatine

to the external process of the pterygoid and forms the wall of a large posterior palatine vacuity (Fig. 6).

The lower jaw is long and slender, two thirds of the length being formed by the dentary. There is a fairly large coronoid process. The angular is large, and the surangular, as displayed externally, is small, and the articular is also small.

The occiput is small and slopes downward and backward. On the inner side of the descending part of the squamosal is a prominent ridge which forms the inner wall of the external auditory meatus and divides off the occiput proper from the squamosal. The condyle is single and rounded.

*Lycosuchus vanderrieti* is a fairly near ally of *Scylacosaurus* but differs in a number of minor details. There does not seem to be a distinct postfrontal,

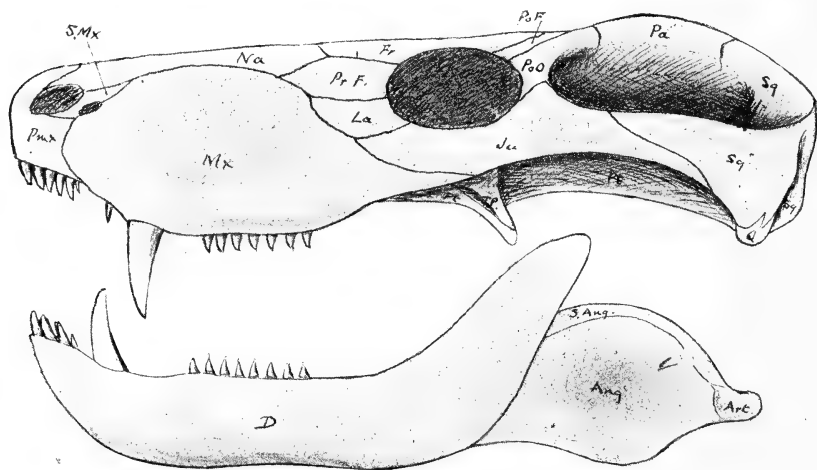


Fig. 5. Skull of *Scylacosaurus sclateri* Broom.  $\times \frac{1}{4}$ .

though the post-orbital is well developed. The squamosal shows the same auditory groove.

*Aloposaurus gracilis* is much smaller than most of the other known Therocephalians but agrees fairly closely with the majority of types. The skull (Fig. 7) is relatively much narrower and deeper than that of either *Scylacosaurus* or *Lycosuchus*. The premaxillary is small and carries five incisors which have a number of vertical ridges. There is a large septo-maxillary. The maxillary is deep, and has a slender portion which extends backwards some distance below the orbit. The lachrymal is rather small, and the prefrontal of fair size. The nasal is narrow but broader behind. The frontal is much longer than broad, and a slight median ridge is formed by the two. The parietal region is unusually broad and formed mainly by

the parietals and post-orbital. Whether there are distinct postfrontals is not clear. The jugal is a large deep bone. The squamosal is not well shown but appears to be fairly like that of *Scylacosaurus*.

The lower jaw is long and slender and the dentary forms about three fifths. There is a well developed coronoid process. The angular and surangular are similar to those in the other known genera but are of less vertical depth.

The greatest length of the skull is 120 mm.

The dental formula is apparently  $i \frac{5}{4}, c \frac{1}{1}, m \frac{25}{7}$ . The double condition of the canine is due to one replacing an older.

*Scaloposaurus constrictus*. This is the smallest known Therocephalian and one of the smallest of the Therapsida. It has been argued that the mammal-like reptiles are all too large for any of them to have been the mammalian ancestor, but *Scaloposaurus*, *Galechirus* and *Galepus* show that some at least were quite small. Unfortunately nothing but the type skull has ever been discovered.

The maxillary is large and has many small teeth, perhaps the first three of which may be looked upon as canines. The premaxillary is not well preserved but was probably as restored in the figure (Fig. 8). The lachrymal and prefrontals are large. The jugal is long and slender and apparently does not meet the postorbital arch. The squamosal is of the usual Therocephalian type but more slender and there does not seem to be a specialised auditory groove. The parietal region is nearly as broad as the frontal, and there is at least a distinct postorbital which forms a feeble incomplete postorbital arch.

The lower jaw has a very long slender dentary with a small coronoid process. The angular is large and the surangular probably small.

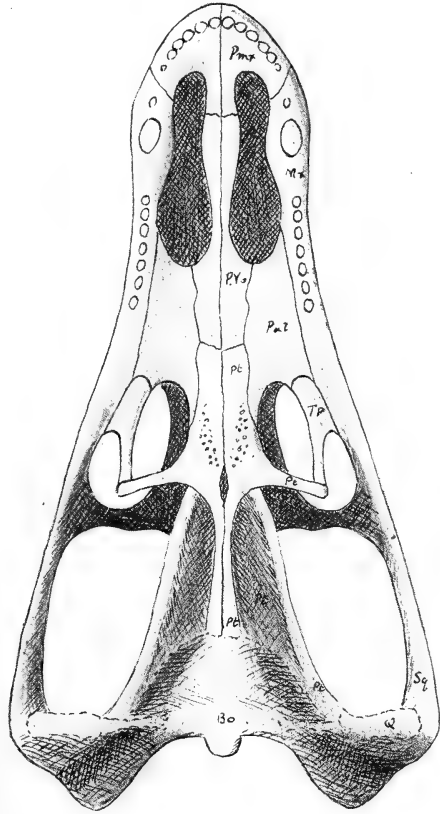


Fig. 6. Under side of skull of *Scylacosaurus sclateri* Broom. Slightly restored.

The dental formula is probably  $i^6, c^3, m^9$ .

In some respects *Scaloposaurus* is the most primitive of the Therocephalians and approaches the Dromasaurian genera *Galechirus* and *Galepus*.

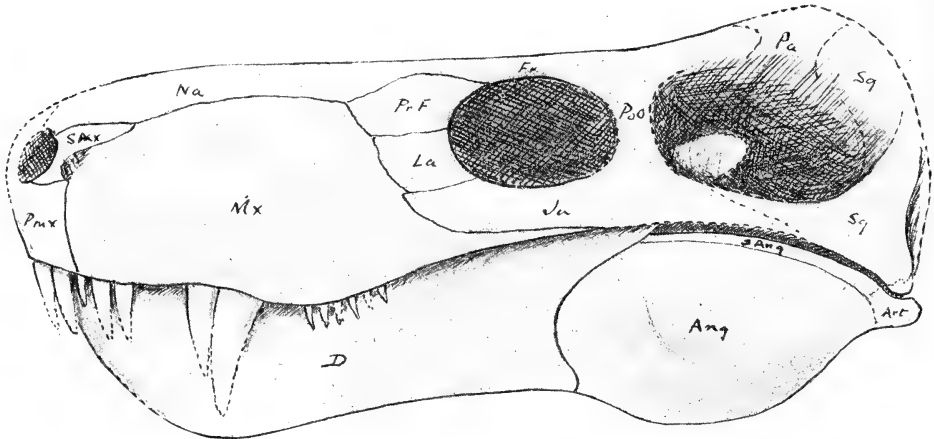


Fig. 7. Skull of *Aloposaurus gracilis* Broom. Nearly nat. size.

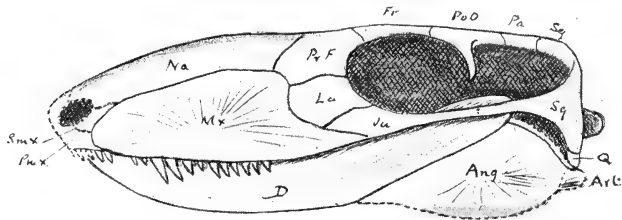


Fig. 8. Skull of *Scaloposaurus constrictus* Owen.  $\times \frac{3}{2}$ .

#### *Anomodontia.*

The Anomodonts form a very well defined group of highly specialised Therapsidan reptiles which are perhaps the most striking and characteristic members of the Karroo fauna; and they are certainly the most abundant.

The most typical and the first discovered genera are the tusked *Dicynodon* and the tuskless *Oudenodon*. Whether or not *Oudenodon* may be the female of *Dicynodon* is still an unsettled point. Owen, Lydekker and Broom have all considered the suggestion and come to the conclusion that the probabilities are rather in favour of the genera being distinct. As time goes on, however, the evidence seems to be getting stronger in favour of *Oudenodon* being but the female *Dicynodon*. Certain it is that wherever *Dicynodon* occurs *Oudenodon* is also to be met with. Until recently only *Dicynodon*

was known to occur in the Upper Beaufort Beds (Upper Triassic) but *Oudenodon* is now also known to occur. Further, while many of the species of *Oudenodon* seem to differ markedly from the known species of *Dicynodon* others are so similar that it is impossible to say to which genus some specimens belong till the presence or absence of the tusk has been determined. Further, among the Endothiodonts, the genera seems to run in pairs, the tuskless *Esoterodon* and the tusked but otherwise very similar *Cryptocynodon*, and the tuskless *Opisthoctenodon* closely allied to the tusked *Pristerodon*. While all these facts seem in favour of the tusked Anomodonts being the males and the tuskless the females, both males and females of *Lystrosaurus* must have been tusked, for though many skulls of *Lystrosaurus* are known, no skull the least like *Lystrosaurus* but tuskless has ever been discovered; and again all the specimens of *Cistecephalus* are tuskless so far as known. The two specimens in the British Museum with tusks are unquestionably wrongly referred to *Cistecephalus* and are really fragmentary skulls of small *Dicynodonts*.

Though the Anomodonts form such a well defined group they do not differ from the more primitive Therapsidans nearly so much as would appear at first sight. The large toothless beak with the modification of the arches and palate to suit it are the most striking specialisations. The Endothiodonts, with molar teeth, to some extent connect the *Dicynodonts* with the lower forms, but except for the presence of molars they agree closely with *Dicynodon*.

*Dicynodon* and *Oudenodon* are the least known Anomodont genera, nearly every detail of the structure being known of both the skull and post-cranial skeleton.

The powerful beak is formed by the peculiarly developed premaxillaries and maxillaries (Fig. 9). In no Anomodont genus is there any evidence of incisors and the premaxillaries are further remarkable by being ankylosed at a very early period. The maxillary is relatively short and has either a tusk or a tusk-like bony process. In *Dicynodon* the tusk is usually very powerful and directed mainly downward, the mandible passing between the two tusks. On the palatal surface the premaxillaries show largely, forming most of the hard palate. The maxillaries form a rudimentary secondary palate. Hitherto no evidence of a septomaxillary or of paired prevomers has been obtained in any Anomodont. The nasals are usually to some extent separated by the median process of the premaxillaries. The prefrontals, lachrymals and jugals are pretty much like those of more normal Therapsidans. The vomer is, as in mammals, an unpaired median bone. There are well developed palatines, which also help in the formation of the rudimentary secondary palate, but there are no transpalatines. The ptery-

goids are large, with long anterior processes which pass forward and slightly outward, and long posterior processes which extend to the quadrates. There is a pair of long slender epipterygoids. In *Dicynodon* postfrontals are usually absent but occasionally small ones are present in other Anomodonts. The postorbitals, on the other hand, are always very large and usually form the whole inner wall of the temporal fossa. The parietals are small, and in front of the pineal foramen is a median preparietal bone. The squamosal is of very large size, stretching, from the postorbital and parietal above, downwards by the side of the occipital to support the quadrate and forwards to form the zygomatic arch with the jugal. In some Anomodonts it even extends forward to meet the maxilla *e. g.*, *Lystrosaurus*. The quadrate is a fair sized bone which lies in front of and below the descending portion of the

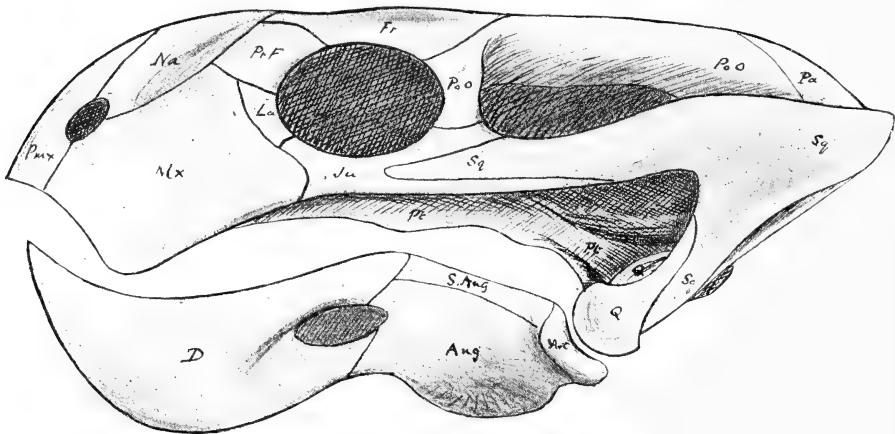


Fig. 9. Skull of *Oudenodon gracilis* Broom. Nat. size.

squamosal. The occiput is large and massive, formed by a small basioccipital and two very large exoccipitals. Above these is a median bone which may be either supraoccipital or interparietal, probably the former. Inferiorly the exoccipital has two short descending processes supported in front by two processes from the basisphenoid. Between this basioccipital process and the quadrate lies a short dumb-bell shaped tympanic bone.

The lower jaw is composed of a large dentary, which becomes ankylosed with its neighbor as age advances, well developed angular, surangular and articular bones with a smaller splenial. There is no coronoid process and no coronoid bone.

The post-cranial skeleton is very mammal-like. The shoulder girdle is interesting from the fact that the cleithrum is still retained. The digital formula is 2, 3, 3, 3, 3. The pelvis is like that of the mammal in the forward

direction of the ilium and the presence of a small obturator foramen. There are no abdominal ribs and no ossified prepubis.

There are a few specialisations of the Dicynodont type. *Lystrosaurus*, which first appears in beds which are probably Lower Triassic, is an aquatic modification where the head is twisted to bring the eye and nostril as near the

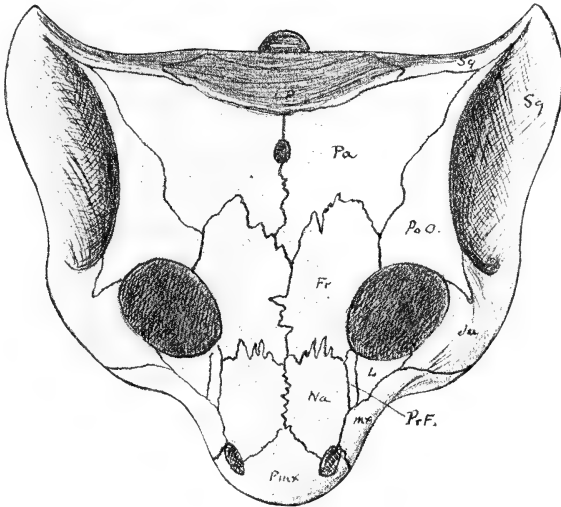


Fig. 10. Skull of *Cistecephalus microrhinus* Owen. Nat. size.

upper surface of the water as possible. The limbs are short and feeble and the joints cartilaginous.

*Cistecephalus* is a small Anomodont which only occurs in beds which are believed to be Upper Permian (Fig. 10). It is never tusked and the beak is small. The chief peculiarity is the great breadth of the parietal region which to a large extent roofs over the temporal fossa. The arrangement of the bones is seen in the figure given.

#### NORTH AMERICAN PERMIAN FAUNA.

The Permian Fauna of North America is, like that of South Africa, of the very greatest interest. Professor Williston has recently written on the relationships of this fauna and concludes that it has been evolved in isolation from the rest of the world and that it has no near affinities with other faunas. The South African fauna belongs mainly to Middle, and Upper Permian and Triassic; the North American is mainly a fauna of the Lower Permian and to some extent Upper Carboniferous.

The principal types of Amphibians and Reptiles may be placed in seven groups or orders. The Amphibians belong to: (1) The Temnospondyli, a group of Stegocephalian Amphibia characterised by the vertebræ having large intercentra and small paired pleurocentra. *Eryops*, *Trimerorachis* and *Acheloma* are the best known types. *Cricotus*, though having in certain regions large centra alternating with disc-like intercentra, is usually also placed in this group. (2) A group of which *Diplocaulus* may be regarded as the type. (3) A group of which *Lysorophus* may be considered as the type. And (4) a division of which *Gymnarthrus* is the type.

The Reptiles are much better known than the Amphibia. They belong to three orders or groups. The best known are the (1) Pelycosauria, of which the principal types are *Dimetrodon*, *Naosaurus* and *Edaphosaurus*. The next group is (2) the Cotylosaurs, of which the best known type is *Diadectes*. The (3) third group is also sometimes included in the Cotylosauria but is not very nearly related to *Diadectes*. It contains such types as *Pario-tichus* and *Labidosaurus*. A number of genera are too imperfectly known to admit of classification with much certainty, but possibly most of them can be placed in one of these three groups.

#### *Temnospondyli.*

I am not satisfied that the American types are closely allied to the European, such as *Archegosaurus*, but the American seem to be of a considerably higher type. The vertebræ, however, are typically rhachitinous. They are best known in *Eryops*, *Trimerorhachis* and *Acheloma*.

*Cricotus* differs in having many of the vertebræ of the embolomeric type.

*Trematops*, which has recently been described by Williston, is a most remarkable type of temnospondylous Amphibian which has a temporal fossa. In most other respects it seems allied to *Eryops*.

#### *Diplocaulus.*

*Diplocaulus* is placed by Williston among the Microsauria, as the vertebræ are completely ossified, but he admits that it represents a more highly organised type than that seen in the ordinary Microsauria.

#### *Lysorophus.*

There has been considerable difference of opinion as to the affinities of this little snake-like form. There can, however, be no doubt that it is an Amphibian; the only question being whether it can be placed in any of the known groups.



The skull, as shown by Williston, agrees with the Urodela and differs from the Gymnophiona and most primitive groups in having the orbits open and in the structure of the suspensorium. Even in many minor details it approaches the Urodela and is remarkably like that of *Amphiuma*. Doubtless in one or two points *Lysorophus* is more primitive but there seems better reason for placing it with the Urodela than with any other recent or extinct group. The living Urodeles present a considerable variety of type, and are evidently the somewhat degenerate descendants of a large and varied order, and *Lysorophus* seems to be one of the specialised but less degenerate early members.

In a recent paper Moodie criticises this conclusion and on account of the presence of ribs and the snake-like character prefers to place *Lysorophus* in the Gymnophiona. A snake-like character is apparently fairly easily acquired in many groups, and among recent lizards we can see all the stages, and it is remarkable to note in how many different orders it has been independently acquired. Even in living Urodeles we get a very near approach to the snake-like character in *Amphiuma*. The presence of ribs in *Lysorophus* is a more important character, but ribs are so generally present from fishes upward that when one finds a group of animals where they are generally rudimentary, as in the Amphibia, the more natural conclusion seems to be that short ribs is a degenerate character rather than a primitive. Long ribs are characteristic of the Microsauria, and though they are short in the Branchiosauria the evidence seems to me rather in favour of the long rib being the primitive condition.

#### *Diadectes.*

*Diadectes* is one of the best known of the primitive Permian reptiles and one of the most interesting. In some respects it is much specialised, in others it is very primitive. The teeth are large and broad, and the lower jaw powerful, and for its suspension the quadrate is of very large size.

The maxilla is powerful, but is completely divided from the nasal by the lachrymal extending forward to the nostril (Fig. 11). The jugal is deep and articulates with the post-orbital, squamosal and quadrato-jugal. The postorbital is large. The postfrontal and prefrontal form the whole upper margin of the orbit. The squamosal extends from the parietal down to the quadrato-jugal and jugal and forms most of the support for the very large quadrate. The quadrato-jugal supports the lower part of the quadrate and forms the lower part of the back of the temporal wall.

The quadrate is very large and extends nearly as far up as the squamosal. It also has a large inferior process which passes forward to meet the ptery-

goids. The pterygoids are small quadrangular bones which meet the prevomers, palatines, and transpalatines in front. They form small pterygoid processes (Fig. 12). The palatines are small and form an imperfect secondary palate. There appear to be a pair of small transpalatines. The prevomers are long and narrow and have each a longitudinal row of teeth. The

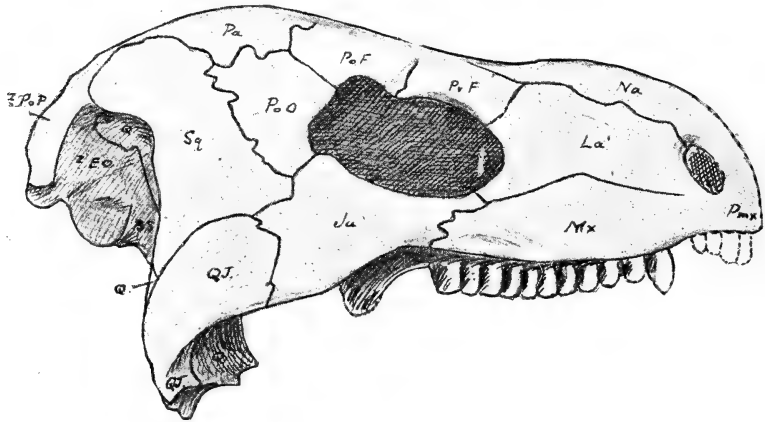


Fig. 11. Skull of *Diadectes phaseolinus* Cope. About  $\frac{1}{3}$  nat. size.

The occiput is massive. The condyle is large and flat. The elements are so anchylosed that the limits of each cannot be made out. A distinct suture however is present between the basioccipital and the basisphenoid.

The vertebræ are massive, and a number of the anterior ribs are expanded into broad bony plates.

The limb girdles are large and heavy, though the limbs are rather feeble.

### *Pariotichus.*

*Pariotichus* is one of the best known of the American Permian reptiles. It is a small form with a roofed temporal region, and though in many respects it is primitive in others it is pretty highly evolved. It is very slightly generalised<sup>1</sup>.

Cope placed it in the Cotylosauria, but though it agrees with *Diadectes* in having the temporal region roofed, it differs from it so greatly that unless the term Cotylosauria is used in a very wide sense it cannot well include the two genera. All confusion is avoided however if *Pariotichus* is considered as a type by itself.

<sup>1</sup>[The word "generalised" is here apparently a *lapsus* for "specialized".—Ed.]

The skull is broad and flat, and the bones sculptured. The bones of the upper side are well seen in the figure given (Fig. 13). The upper surface is mainly formed by the nasals, frontals and parietals. There are distinct and well developed prefrontals, postfrontals, and postorbitals. The lachrymal is very large and extends to the nostril. The maxilla, on the other hand, is very narrow and forms but a small part of the side of the snout. There is a well developed septomaxillary. The jugal is very large, and posteriorly meets the squamosal and the quadrato-jugal. The squamosal is a large

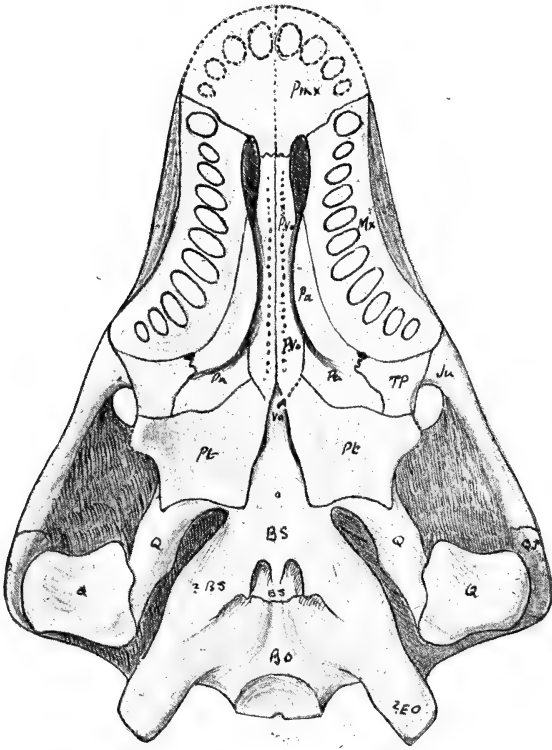


Fig. 12. Under view of skull of *Diadectes*. Slightly restored.

square bone which articulates broadly with the parietal above and with the quadrato-jugal below. It forms part of the back of the skull and has a groove for the auditory canal. The quadrato-jugal is about a third of the size of the squamosal. There is no evidence of a distinct prosquamosal in *Pariotichus*, though there appears to be in *Pantylus*, though whether this latter is allied is at present unknown and rather doubtful. The quadrate shows to some extent on the side view. Behind the parietal at its outer

corner is a small distinct ossification which probably corresponds to the so called "epiotic" of the Stegocephalians and may be preferably called the post-temporal.

The palate is fairly well known. The prevomers are well developed and

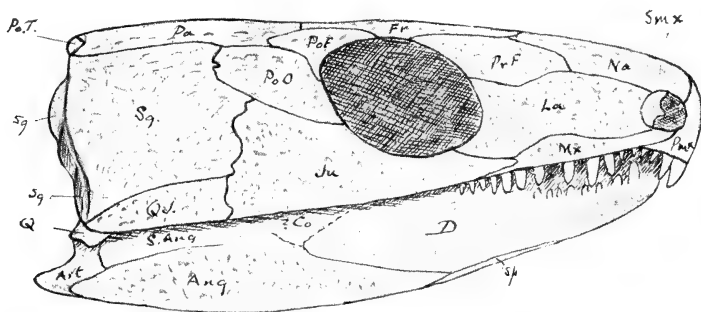


Fig. 13. Skull of *Pariotichus angusticeps* Cope. Nat. size.

lie on the inside of the internal nares. The palatines are also fairly well developed; while the pterygoids are very large and send long processes forward inside of the palatines. They form large pterygoid processes and pass

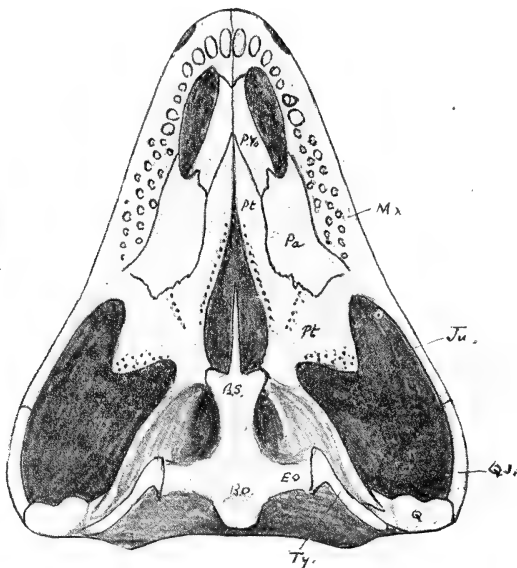


Fig. 14. Under view of skull of *Pariotichus angusticeps* Cope. Slightly restored.

back to meet the quadrates. Teeth are developed on the pterygoids in three groups, as seen in the figure (Fig. 14). A small median vomer—the so called parasphenoid—is present. Between the quadrate and the basi- or exoc-

cipital process lies a slender little bone which seems to articulate with the bones at either end. This is the bone which I believe to be the tympanic. The occipital condyle is single and rounded.

The lower jaw has a large dentary and a large angular, a smaller surangular, apparently a distinct coronoid, and a small articular. A narrow splenial lies inside the dentary.

As the result of the work of Cope, Broili, Case and Williston the postcranial skeleton of *Pariotichus* and its allies is fairly well known. The girdles are well developed but the limbs rather feeble and short. Abdominal ribs are present in at least some members of the group. The digital formula is doubtful but Williston says that "quite surely it was not that of the modern lizards and *Sphenodon*, 2, 3, 4, 5, 3. In much probability it was 2, 3, 3, 4(3), 2."

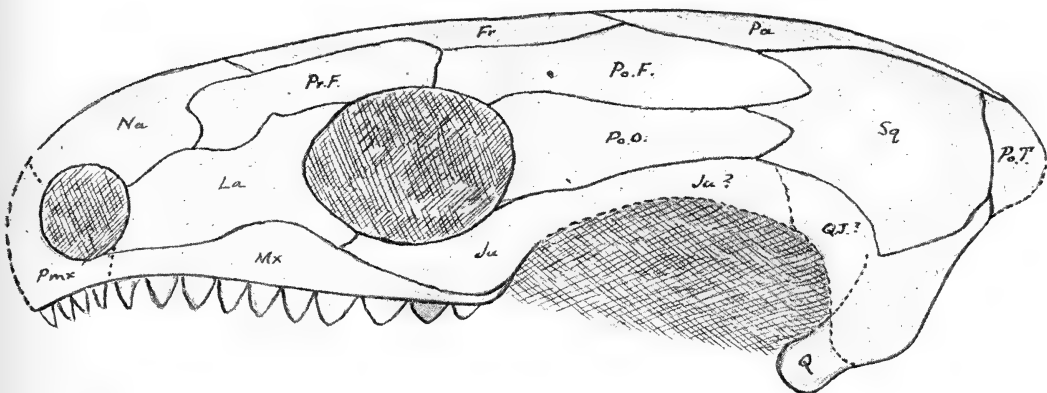


Fig. 15. Skull of *Gymnarthrus* Case. Restored. Much enlarged.

### *Gymnarthrus.*

During my short stay in New York Dr. Case kindly allowed me to examine a small skull which he had recently discovered, and which he is describing under the name *Gymnarthrus*. Though Case is elsewhere<sup>1</sup> describing the specimen it is of such great interest and its affinities so difficult to decide that I have his kind consent to give an independent opinion.

The skull (Fig. 15) is very small, but fortunately well preserved. Judged by the upper and even by the side view one would incline to the opinion that *Gymnarthrus* is a near ally of *Pariotichus*. The nasals, frontals, parietals,

<sup>1</sup> See *antea*, p. 177.

prefrontals, postfrontals, postorbitals and squamosals are all strikingly like those of *Pariotichus*. Further, the lachrymal is very large and extends to the nostril, and the maxilla is a narrow bone which forms little of the side of the snout; and behind the squamosal there is a post-temporal. In all these characters *Gymnarthrus* agrees with *Pariotichus*. But when one examines the palatal aspect of the skull one finds a condition of affairs very unlike that of the reptile. The occipital condyle appears to be double, and the pterygoids do not meet in the middle line. There is in the middle line either a single very large vomer (or parasphenoid) or a large basisphenoid and a fairly large true vomer or parasphenoid in front. I rather incline to the former alternative. The palatines and prevomers are not displayed but they can be restored with considerable probability.

The quadrate is long and in the specimen extends free much below the squamosal. I incline, however, to suspect that a quadrato-jugal is missing and part of the jugal.

Though owing to the condition of the palate and the occipital condyles I prefer to regard *Gymnarthrus* as an Amphibian, it must be admitted that it shows so many characters also found in *Pariotichus* that it is difficult not to believe that there is a fairly close relationship between them.

In some respects *Gymnarthrus* suggests the Gymnophiona, and if it is really an Amphibian it raises a number of very interesting questions *e. g.*, whether the reptiles may have sprung from more than one group of Amphibians and not, as is generally supposed, all from some ancestral Cotylosaur. The discovery of the Amphibian *Trematops* with a temporal vacuity, further suggests unsuspected possibilities.

### *Pelycosauria.*

The Pelycosaurs are in many ways the most interesting of the North American fossil reptiles. In the strange specialisation of the vertebral spines they are unique and they will always be interesting as among the first discovered reptiles which seemed to have some close affinity with the ancestors of the mammals. As has been already shown, opinions have differed greatly as to whether Cope was right in believing the Pelycosaurs to be related to the South African mammal-like reptiles, and even as to whether the wonderful mammal-like appearances presented by many of the African types in any way represented affinities. Before discussing the question it will be well to examine the structure of the Pelycosaurs.

In view of Case's recently published magnificent work on the Pelycosaurs it might well seem wiser to wait till further specimens had been obtained.

So much, however, depends on a solution and the interpretation of the already known specimens is a matter of such difficulty that a further examination seems permissible.

The types which I have been able to study have been the skulls of *Dimetrodon* in the American Museum, including the very fine one recently found by Case, and Cope's type of *Edaphosaurus*.

*Edaphosaurus.*

Though the type skull of *Edaphosaurus pogonias* is very badly crushed and somewhat imperfect it is in some respects the most important Pelycosaur skull known.

In making restorations of the skull I started with the mandible, which is nearly perfect and practically uncrushed. As the symphysis is perfect the other mandible can be restored and we can determine with much certainty the width of the palate, the inclination of the pterygoid plates, the distance of the quadrates from each other, and the relative position of the quadrates to the upper jaws. As we have the bony arch complete from the parietal, down the squamosal to the quadrate we can obtain the height of the parietal region. And having obtained the relative positions of the quadrates, parietals, premaxillæ and maxillæ with considerable certainty the fitting in of the remaining parts is not a matter of much difficulty.

In like manner the palate can be restored. We can fix the position of the premaxillary and maxillary teeth, the pterygoid plates and the quadrates, and as most of the other structures are preserved their restoration in position is comparatively easy.

The figures given (Figs. 16-18) show my restoration of the side, upper, and under views. The premaxilla is fair sized, and of the usual type. The front of the specimen is too imperfect to show whether there may have been a septomaxillary. The maxillary is long and narrow and appears to be completely separated from the nasal, as in *Pariotichus*, by the forward development of the lachrymal. The shape of the nasals and frontals is shown in the figures. The frontal has a peculiar outward development which with the postfrontal forms a very prominent supra-orbital ridge. The prefrontal is wedged in between the outer part of the frontal and the nasal. The postfrontal is large, and the postorbital small. The shape and relations of almost all the bones of the upper surface of the skull can be made out with certainty. The parietals are well preserved. They are broad and have a large pineal foramen. There is a large temporal fossa bounded above by the postorbital and parietal, and posteriorly by the squamosal. Most of the squamosal is well preserved, but the zygomatic portion is lost and the

structure of the zygoma cannot be made out with certainty. There is a quadrato-jugal, which apparently takes some part in the formation of the zygoma, but there is little evidence as to what extent. There seems to have been a small fenestra between the quadrato-jugal and the squamosal, and in the restoration given an attempt is made to show what are the probable relations of the bones. The quadrate is well developed and fairly well preserved.

The palate is well preserved and can be restored with much probability, the prevomer, palatine and pterygoid of the right side being preserved with the bones in almost their natural relations to each other and to the maxilla.

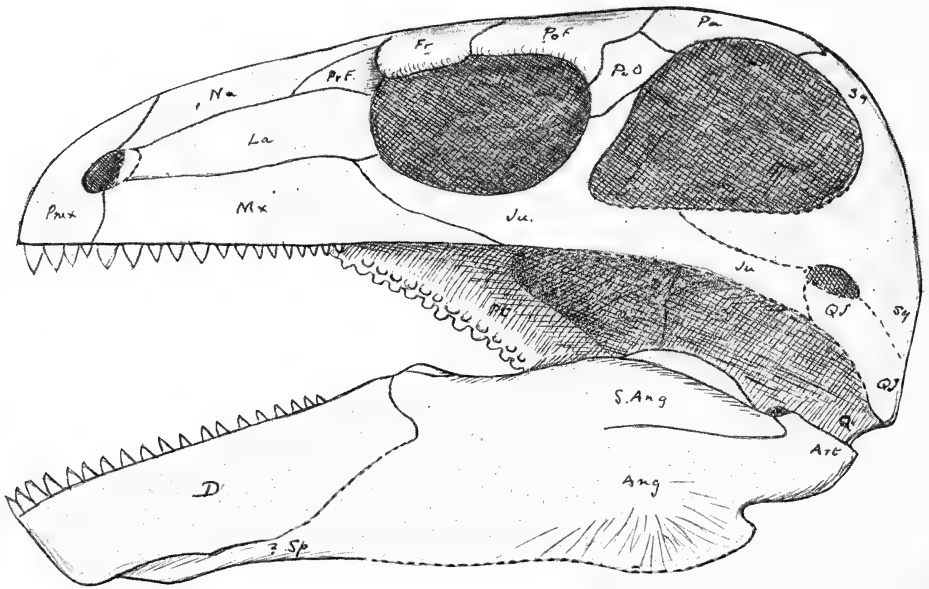


Fig. 16. Skull of *Edaphosaurus pogonias* Cope. Restored.

The prevomers are small and narrow and lie between the internal nares. Each has a row of small rounded teeth. The palatine and pterygoid together form a large plate covered with small rounded teeth. The shape of the bones and the arrangement of the teeth will best be understood from the figure given. The anterior third of the plate is in my opinion formed by the palatine, and in the specimen there is a slight displacement along the suture. There is apparently a rather large postpalatine foramen, but there does not appear to be a transpalatine bone. The basisphenoid is well developed and supports the pterygoids. There is a distinct vomer (parasphenoid). The occipital condyle is single and rounded. The bone



which Cope, Case, and others have regarded as the stapes I regard as the tympanic. It bears the same relations to the basioccipital and quadrate as does the tympanic in *Dicynodon*, differing mainly in fact that, as in *Edaphosaurus*, the quadrate is large and flat, the tympanic has its outer half flattened out to lie on the quadrate. I am not satisfied that there is a bone behind the parietal which might be looked upon as a postparietal.

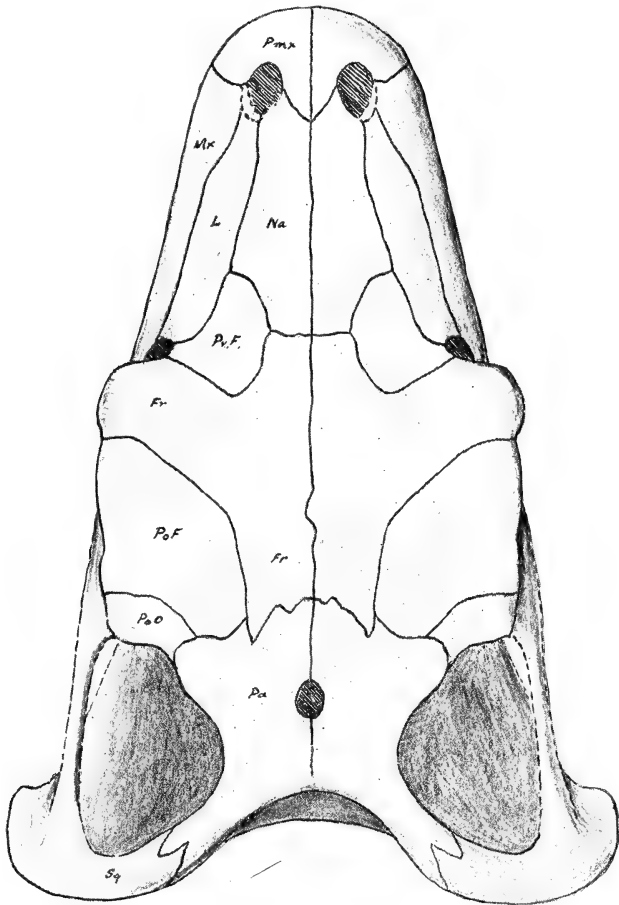


Fig. 17. Top of skull of *Edaphosaurus pogonias* Cope.  $\times \frac{3}{4}$ . Restored.

The dentary forms less than half of the mandible. The angular and surangular are both well developed, and the articular is distinct. The splenial appears to be large.

In my restoration I have shown the teeth different from what is shown in

both Cope's and Case's figures, or even from what appears to be the condition from an examination of the specimen. The large maxillary teeth appear

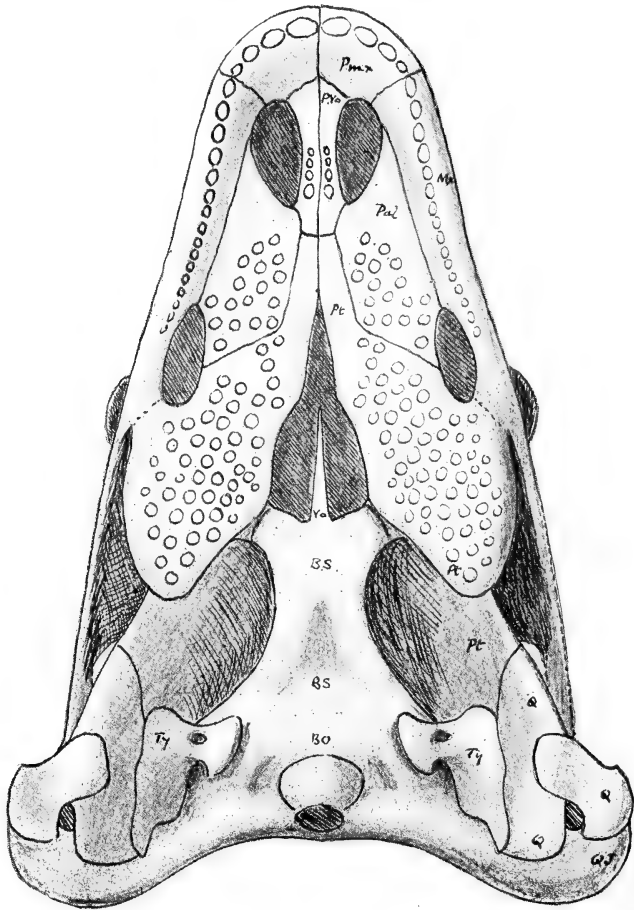


Fig. 18. Lower view of skull of *Edaphosaurus pogonias* Cope. Restored.

to me to have been artificially made by whoever developed the specimen. From the alveoli the teeth are manifestly small and rounded, and like those in the lower jaw.

#### *Dimetrodon.*

*Dimetrodon* is known by a considerable number of pretty well preserved skulls and by practically all the postcranial skeleton. It is a much larger animal than *Edaphosaurus*, and it is less specialised, there being no crushing

plates of teeth. As it is from the restorations of the skulls of *Dimetrodon* that the conclusion has been arrived at that the Pelycosaur is allied to *Sphenodon*, and that the temporal region has two fenestræ as in the Rhynchocephalians the determination of the exact structure is a matter of the utmost importance. The skulls in the American Museum enable one to decide with certainty on all points in the structure of the skull with the exception of two and these we can decide with some probability.

The snout is pretty well known and my restoration (Fig. 19) agrees

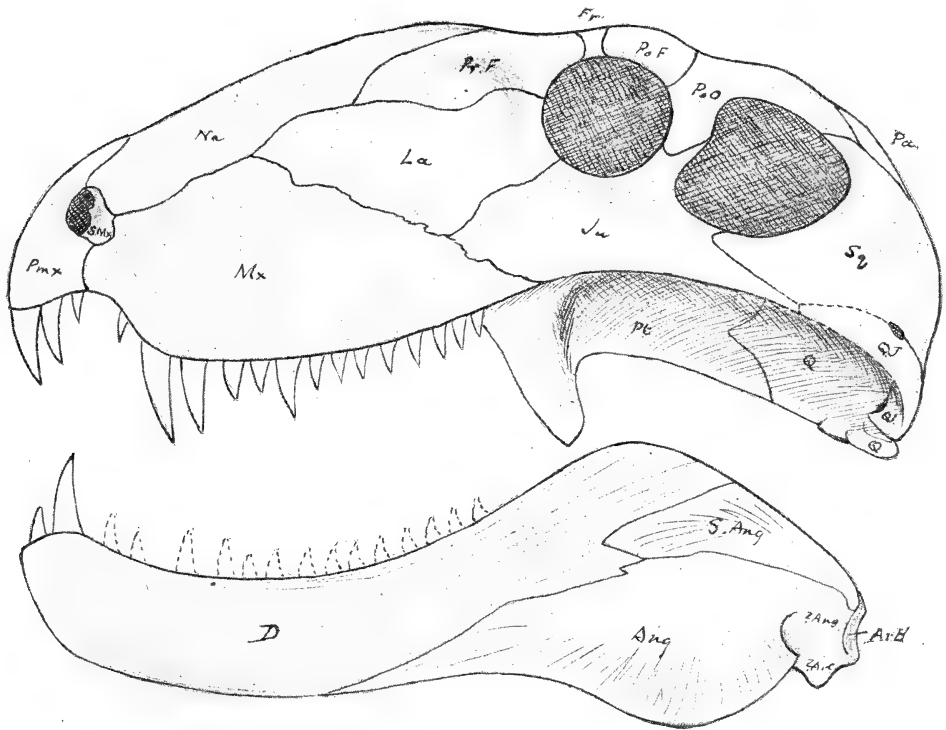


Fig. 19. Skull of *Dimetrodon incisivus* Cope. About  $\frac{1}{3}$  nat. size.

pretty closely with that of Case. The only point where we differ is in the matter of the relative sizes of the lachrymal and prefrontal. I regard the former as large and extending well forward, but not, as in *Edaphosaurus*, extending to the nostril. We are also in close agreement as to the jugal and postorbital, but in the structure of the posttemporal region we differ entirely. In none of the specimens I have examined is the region perfectly preserved, but the principal bones can be made out I think with certainty.

There is a large temporal vacuity, rather larger than the orbit. It is

bounded in front by the postorbital arch which is formed by the postorbital and the jugal. The upper margin is also formed by the postorbital. Posteriorly the fenestra is bounded by a large flattened bone concerning which there is difference of opinion. Baur and Case believe it to be a prosquamosal, but in my opinion it is the squamosal. There is no doubt whatever about the parietal and the postorbital, and they bear exactly similar relations to each other as they do in the Therocephalians and Anomodonts. Posteriorly they both unquestionably meet the upper part of the large bone under consideration in exactly the same way as they meet the squamosal in the African mammal-like reptiles. The large bone inferiorly supports the quadrate and in front meets the jugal: so that in every detail of its relations it agrees with the squamosal of the African forms. Now the African Mammal-like forms approach so nearly to the mammals that there can be no question that the squamosal is rightly identified, and hence we must conclude that the large bone behind the temporal fossa is the true mammalian squamosal.

The next question for consideration is whether there is, as believed by Baur and Case, a small supra-temporal fenestra. Case assures me that there seems to be a distinct one in one of the skulls in the Chicago museum. I regret I have not seen this skull, but so far as I have examined the skulls in New York I can find no trace of any opening. Two of the skulls are so well preserved that if the opening really existed it ought to show. Further, *Edaphosaurus* is undoubtedly closely allied to *Dimetrodon*, and though the skull is in many ways imperfect it is so perfectly preserved, in the post-temporal region as to conclusively show that *Edaphosaurus* at least has no supratemporal fossa, and that being so it would require very positive evidence to establish a supratemporal fossa in *Dimetrodon*. Now the Chicago skulls on which Case bases his conclusions are not well preserved being much broken and somewhat crushed, and further the sutures cannot apparently be very distinctly seen, judging from Case's figures (plate 17 and plate 8), so that even supposing *Edaphosaurus* were not known I should still conclude that the evidence of the New York specimens against a supra-temporal fossa was much stronger than the evidence of the Chicago specimens for a supra-temporal fossa, and until a good uncrushed specimen is discovered showing a supra-temporal fossa I shall conclude that there is no supra-temporal fossa in the Pelycosaurs. Whether there be a small superior fossa or not there is no question that the large fossa is the homologue of the temporal fossa in the African Mammal-like reptiles.

Below the large squamosal there is a distinct quadrato-jugal. In no skull of *Dimetrodon* is it well preserved and there seems to be some doubt concerning its extent forward and its relations to the squamosal and the

jugal. From the evidence obtained from specimen 4034, and to a less extent from other specimens, I incline to regard the quadrato-jugal as passing forward to meet the jugal and forming a small fenestra with the squamosal, as I have shown in the restoration. It must be clearly understood, however, that the restoration of this region is largely hypothetical.

The quadrate is a large bone which has a large flat plate passing forward to meet the pterygoid. The palate is well known and my restoration (Fig. 20) agrees pretty closely with Case's, differing mainly in the proportions of certain of the bones. The pterygoids I regard as narrower than Case does, and I think there is a distinct post-palatine foramen. The basisphenoidal and basioccipital region I regard as flatter, and I have placed in position the bone which I regard as tympanic.

Concerning the occipital region there is some doubt. There is unquestionably a well developed exoccipital which sends a process outward to meet the descending squamosal. This is the process called paroccipital by Case. I should rather restore it as passing about as much downward as outward (as shown in Case's fig. 7, plate 11). Above the foramen magnum there is a broad flat plate which may be supraoccipital, but no sutures can be made out. The exact structure behind the large squamosal must remain for the present in doubt. In some specimens one might persuade oneself that there was a distinct postparietal bone and also an elongated post-temporal.

In others it is by no means certain that such bones can be made out. The parietal unquestionably has an outward and backward process by the side of the postorbital, which meets the squamosal. Behind the inner part of the parietal there is probably a bone separating it from the supraoccipital. Then behind the outer process of the parietal there is also some bony element above the supra- or exoccipital. Whether, however, this is a post-temporal or a part of the squamosal I cannot determine in the New York specimens.

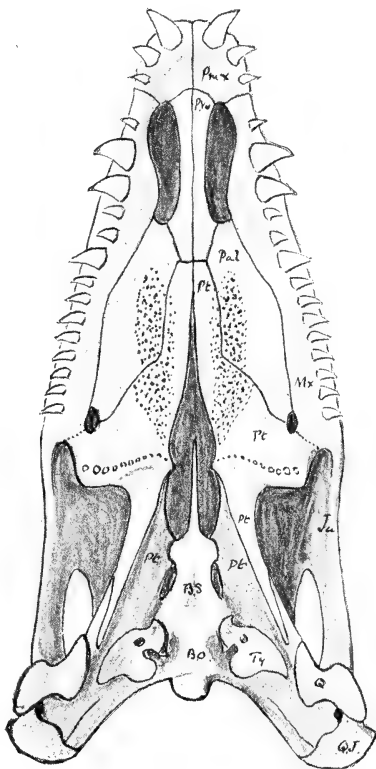


Fig. 20. Under side of skull of *Dimetrodon*.  
Much reduced.

The mandible is well preserved. The dentary is large and forms about two thirds of the jaw. There is no developed coronoid process to the dentary though the coronoid region is occupied by this bone. There is no coronoid bone. The angular is large and forms a rounded angle to the jaw. The surangular is comparatively small. The articular is largely hidden by the membrane bones. In Case's fig. 4, plate 9, the parts marked articular and prearticular I regard as parts of the angular, the true articular being the part behind and scarcely seen from the outer side.

To Case's very full description of the post-cranial skeleton I have nothing to add.

#### THE APPARENT RESEMBLANCE OF THE AMERICAN TYPES TO THE SOUTH AFRICAN.

Though it is many years since Cope first called attention to the resemblance between some of the American and African types, of later years zoölogists have been more impressed by the differences. Like most others I had regarded the resemblances as more due to a parallel development than to affinity and I was a little surprised to find that the resemblances were of a more fundamental nature than had been supposed. Not only do certain American types resemble, somewhat remotely of course, African forms, but the whole fauna has got an African look about it that is very striking.

Williston regards the American Permian reptiles as belonging to three groups — the Pelycosaurs, the Cotylosaurs proper, and the Pariotichus group; and it certainly is very remarkable that some years ago writing of the reptiles of South Africa I placed them in the groups Procolophonia, Pareiasauria, Therocephalia, Anomodontia and Cynodontia. If we unite the allied mammal-like groups Therocephalia and Anomodontia under the Therapsida and omit the Triassic Cynodontia, we get our principal Permian reptiles also in three groups, and further, the three groups correspond in many ways to the American. The Pelycosaurs resemble the Therapsida, the Cotylosaurs the African Pareiasauria, and the Pariotichus group the Procolophonia. A short comparison will show that there is a fundamental affinity between the faunas.

#### THE PELYCOSAURIA COMPARED WITH THE THERAPSIDA.

While the Pelycosauria differ from the Therapsida sufficiently to justify their being kept in a distinct order they are nevertheless in my opinion closely related. Let us compare the various parts of the skeleton in each.

The skull of the Pelycosaur resembles that of the Therapsida and differs from that of all other reptiles in having a single temporal fossa bounded by the postorbital, squamosal and jugal. In Cynodonts, Therocephalians, and some Anomodonts the parietal forms part of the fossa wall through the postorbital and the squamosal failing to meet, but most Anomodonts, Dinocephalians and Dromasaurians show what is manifestly the primitive condition where the parietal does not touch the margin of the fossa. The general arrangement of the bones of the snout and orbit is similar in the typical Therapsidans and Pelycosaurs. The occipital region in both is fairly similar though possibly the Pelycosaurs retain a primitive postparietal and posttemporal which certainly are lost in the Therapsidans. The suspensory arch is in both formed by a huge squamosal, the Pelycosaurs differing from most only in retaining the quadrato-jugal which is lost in all Therapsidans except the Dinocephalians. But in these latter the arrangement of jugal, squamosal and quadrato-jugal is strikingly like that of the Pelycosaurs.

The palate in the Pelycosaurs is distinctly Rhynchocephalian. So it is in the Therocephalia. In the retention of the transpalatines the Therocephalian type is more primitive, but in having the prevomers toothed the Pelycosaurs are the earlier type. In the Therapsida the palate varies greatly. The Anomodonts, Dinocephalians, and Cynodonts have, like the Pelycosaurs, all lost the transpalatines.

The lower jaw of the Pelycosaurs agrees very closely with that of the Dinocephalians and Dromasaurians and fairly well with that of the Anomodonts. The Therocephalian jaw differs in the great development of a coronoid process, and the Cynodont in the greatly increased size of the dentary and the relative reduction of the other elements.

The vertebræ of the Pelycosaurs agree pretty closely with those of the Dinocephalia, less closely with those of the Anomodonts and Therocephalians. The sacrum of the Pelycosaur has 3 vertebræ while in the Dinocephalia and the Anomodontia 4 is the number in those types where it is known.

The shoulder girdle is exactly of the same type in the Pelycosaurs and the lower Therapsidans. A cleithrum certainly occurs in the Dinocephalia and the Anomodontia and probably in the Therocephalia. In the Therocephalia, the Dinocephalia and the Dromasauria the scapula is flat without a specialised acromion. The Dinocephalia have a large interclavicle very similar to that of the Pelycosaurs.

The humerus in the Therapsida varies considerably. In the Anomodonts the delto-pectoral ridge is very large, and it is also large in the Dinocephalians, but in the Dromasauria and the Therocephalia the humerus is long and the ridge only moderately developed. The Pelycosaur humerus resembles the

Therapsidan in having an entepicondylar foramen and in the well developed delto-pectoral ridge and on the whole it is pretty like that of the Dinocephalians and differs less from this latter type than do most of the other Therapsidans.

The ulna in the Pelycosaur is like that of the Therapsidan in having a well developed olecranon process.

The carpus, so far as known in the Pelycosaur and Therapsidans, agrees fairly closely as regards elements, both belonging to the generalised Rhynchocephalian type.

The Pelycosaur manus has the metacarpals increasing in length from the first to the fourth and the digital formula is 2, 3, 4, 5, 3. In the Dromasauria and Therocephalia, and to a slight extent in the Cynodontia, there is the same increase in the length of the metacarpals in passing outward, but in all the Therapsida the digital formula so far as known is 2, 3, 3, 3, 3. In the Anomodonts the metacarpals are subequal.

The pelvis in the Pelycosauria is of the plate-like type. In the Anomodontia and the Cynodontia the type is much modified by the forward extension of the ilium and by the formation of an obturator foramen, but in the Dromasauria and apparently also in the Dinocephalia and the Therocephalia the pelvis is essentially similar to that of the Pelycosaur.

The tarsus is not sufficiently well known in the Therapsidan types to admit of comparison with the Pelycosaurian. For the hind limb the digital formula of the Therapsidan is 2, 3, 3, 3, 3, and of the Pelycosaurians 2, 3, 4, 5, 4.

From these points of comparison I think one must conclude that the Pelycosauria are allied to the Therapsida. In some respects the former are more specialised but in most they are more primitive. The skull while essentially similar in the two types is more primitive in the Pelycosaur than the Therocephalia in the retention of the quadrato-jugal and perhaps of a postparietal and posttemporal. It is less primitive in the loss of the transpalatine. The Dinocephalia alone among the Therapsida retain the primitive quadrato-jugal. The Dromasauria alone have the primitive character of the lachrymal meeting the septomaxillary, a character also seen in *Edaphosaurus*, and the possession of abdominal ribs, also present in some Pelycosaurians.

In retaining the typical Diapsidon digital formula the Pelycosaur is more primitive, but though the Therapsida have acquired the mammalian formula of 2, 3, 3, 3, 3, to suit the placing of the feet under the body and to bring the toes into line, we can see from the condition of the metatarsals and metacarpals in the Dromasauria that this formula has probably only been recently acquired and that the feet are not yet completely suited to the new mode of walking.



The conclusion to which I come is that the Pelycosaurs and the Therapsida had a common ancestor in the Upper Carboniferous times, which was characterised by having the typical Diapsidan digital formula, abdominal ribs, a single temporal fossa, a quadrato-jugal bone, and a Rhynchocephalian palate. Such an ancestor could be so near the ancestral Rhynchocephalia or Diaptosauria that though it only had a single temporal fossa corresponding to the lower one in *Sphenodon* it ought to be regarded as a Diaptosaurian, and though the Pelycosauria are specialised in a number of respects I should still keep them in the Diaptosauria.

The South African Therapsidans have sprung from the same ancestor but have evolved in a different way. By a change of habit the limbs have become more powerful and by the adoption of the habit of walking with the body off the ground the digital formula has been changed from 2, 3, 4, 5, 3, to 2, 3, 3, 3, 3. The changes in the skull are of less importance, the only marked one being the loss of the quadrato-jugal. The Dromasauria are perhaps quite as near to the common ancestor as are the Pelycosaurs, but as they are on the Mammalian line I should keep them in the mammal-like phylum and regard them as the most primitive division of the Therapsida.

#### DIADECTES COMPARED WITH PAREIASAURUS.

Though the resemblance between *Diadectes* and *Pareiasaurus* is less striking than between the Pelycosaurs and the Therapsidans it is nevertheless pretty marked.

If a vertebra of *Diadectes* had been found in South Africa and submitted to me for determination I should have had little hesitation in referring it at least to some Pareiasaurian, even though *Pareiasaurus* itself has not the zygosphenal articulation. The arrangement of the zygapophyses and the transverse processes and the mode of articulation of the head of the rib are all typically Pareiasaurian.

The skull appears to differ considerably. *Diadectes* has a highly specialised type of palate and dentition; *Pareiasaurus* has a more primitive palate and dentition specialised in a different direction. Still in essentials the palates are similar. Further, there is probably a close agreement in the structure of the upper part of the skull. The quadrate is much larger in *Diadectes* but so far as is known the arrangement of the bones of the temporal region is similar. The occiput in *Diadectes* is more highly developed and more completely ossified but probably the elements are as in *Pareiasaurus*. Both genera have a flat condyle.

The limbs and limb girdle appear to be fairly similar except that the

limbs of *Diadectes* are feeble, those of *Pareiasaurus* relatively very large and powerful.

Both may have had a common ancestor which resembled *Diadectes* in the limbs and *Pareiasaurus* in cranial structure. *Diadectes* has a very specialised skull and teeth, *Pareiasaurus* a more primitive skull but greatly developed limbs.

#### PARIOTICHUS COMPARED WITH PROCOLOPHON.

The resemblances of *Pariotichus* to *Procolophon* are in many ways striking.

The skull is very similar in the two genera, practically all the elements agreeing except in relative development. *Pariotichus* is much more primitive in having the lachrymal extending to the nostril and in the feeble development of the maxilla, also in retaining the broad temporal region and the postparietal bones. *Procolophon* has the temporal region much reduced, and the quadrato-jugal highly specialised. It further retains the transpalatine which appears to be lost in *Pariotichus*. The palatal structure in each is similar, and both have a rounded occipital condyle.

The vertebræ are fairly alike in the two genera and the limbs bear a considerable resemblance. The digital formula differs, *Procolophon* having the typical Diapsidan formula and *Pariotichus*, according to Williston, probably the formula 2, 3, 3, 4(3), 2. There is also a considerable difference in the structure of the carpus and tarsus.

On the whole *Pariotichus* is a primitive member of some reptilian group of which *Procolophon* is a late representative — more highly evolved in some respects, considerably specialised in others, and degenerate in a few.

#### COMPARISON OF THE AMERICAN PERMIAN STEGOCEPHALIANS WITH THOSE OF SOUTH AFRICA.

Unfortunately so little is known of the South African Permian Stegocephalians that it is difficult to compare them with those of America. Only one genus is known at present from the lower Karroo beds, namely *Rhinesuchus*, and this one very imperfectly. It is, however, very interesting to note that many years ago Lydekker believed that the African animal belonged to the American genus *Eryops*. Though in this he was apparently wrong, *Rhinesuchus* is apparently closely allied to the American form and pretty certainly belongs to the Temnospondyli. In the Upper Karroo beds, which are of Triassic age, a number of Stegocephalians are known, and

some may perhaps be allied though remotely to the American Permian types. *Batrachosuchus* was, when described by me some years ago, thought to perhaps come nearer to *Diplocaulus* than to any other previously known form. *Bothryiceps* is a small temnospondylous form.

#### CONCLUSIONS.

Taking all the facts into consideration it seems to me probable that in Upper Carboniferous times there appeared in the northern part of South America a primitive land vertebrate fauna comprising among other types temnospondylous amphibians, primitive Cotylosaurians, and primitive ancestral Pelycosaur. Before the conclusion of the Carboniferous period this South American fauna invaded North America and almost immediately afterwards the northern group became isolated. The isolation continued during at least the whole of the Lower Permian times and these isolated types became greatly specialised in their struggle with some adverse conditions. What the conditions were we do not know and no satisfactory explanation has, I think, been given of the development of the enormous spines of the vertebræ in the Pelycosaur. Nor do we know what caused the extinction of the whole fauna about Middle Permian times, but most likely some change in climatic conditions.

In South Africa the first Karroo reptile to appear is *Mesosaurus*, which is found in beds a little above the Dwyka tillite. It is certainly generically similar to the *Mesosaurus* of Brazil and closely allied specifically. This occurrence of *Mesosaurus* on both sides of the Atlantic, as well as a series of plants which are specifically identical in Brazil and South Africa, renders it practically certain that there was a land connection between South America and South Africa in Lower Permian times and that animals might have migrated from what is now the one continent to the other. There is, however, no evidence that any reptiles other than *Mesosaurus* arrived in South Africa till some considerable time after the origin of the Permian. Perhaps the reason for this may be that about the beginning of the Permian period South Africa and probably much of South America, Australia and India was, from some cause or other, largely covered by glaciers, and possibly for long afterwards the climate was too severe to allow the more northern or equatorial types to invade the south. In beds which are called Eccia we get the earliest immigrants — a large carnivorous reptile called *Archæosuchus* which may have been a Dinocephalian, and evidence from a tooth of a large undoubted Dinocephalian which was a herbivore. It is, however, not till Middle Permian times that the fauna becomes rich. Then there appear

Pareiasaurians, a considerable variety of Dinocephalians, many Therocephalians, a few Anomodonts, the only known Dromasaurians and a temnospondylous amphibian. Where this great collection of forms came from is of course unknown. They can hardly have originated in South Africa, because though the lower Permian beds are lithologically exactly similar to those of later Karroo times, they are almost entirely unfossiliferous.

It seems to me, however, probable from the general resemblance of the African fauna to the North American Permian that both have come from the common source which I believe must have lived in the northern part of South America. After the invasion of North America in Upper Carboniferous times all connection between North and South America ceased for a very long period. The near relatives of the ancestors of the North American Permian forms left in South America evolved on quite other lines. For long they were probably confined to the Brazilian region owing to the cold prevailing in the South, but ultimately they spread down and across the South Atlantic into Africa where they for the most part arrived during Middle Permian times.

If this conclusion be correct we may regard the American and South African Permian faunas as derived from a common origin but having evolved in quite different directions. The American types undergo many curious specialisations; the African, or more preferably the South Atlantic type, is chiefly remarkable for the great development of the limbs. The Pareiasaurians, the Dinocephalians, the Therocephalians and the Anomodonts have all developed powerful limbs, and not improbably all independently of each other. What may have been the cause we cannot at present tell, but it was a most fortunate thing for the world. It was the lengthened limb that gave the start to the mammals. When the Therapsidan took to walking with its feet underneath and the body off the ground it first became possible for it to become a warm-blooded animal. All the characters that distinguish a mammal from a reptile are the result of increased activity — the soft flexible skin with hair, the more freely moveable jaws, the perfect four chambered heart, and the warm blood. It is further singularly interesting to note that the only other warm-blooded animals, the birds, arose in a similar fashion from a different reptilian group. A primitive sort of Dinosaur took to walking on its hind legs, and the greatly increased activity possible resulted in the development of birds. Birds are reptiles that became active on their hind legs, mammals are reptiles that acquired activity through the development of all four.

**Article XXI.—TERTIARY FAUNAL HORIZONS IN THE WIND  
RIVER BASIN, WYOMING, WITH DESCRIPTIONS OF  
NEW EOCENE MAMMALS.**

BY WALTER GRANGER.

PLATES XX-XXIII.

In the fall of 1908 this Museum received from Mr. N. H. Brown, a civil engineer of Lander, Wyoming, a finely preserved skull of the Upper Eocene rhinoceros *Amyrnodon*, which he had collected on the northern side of the Beaver Divide. This divide forms a part of the southern border of the Wind River Basin, about forty miles southeast of Lander. The specimen gave evidence of a horizon in the basin not previously known to exist there, so far as the writer is aware.

The American Museum expedition of last summer (1909) examined this horizon carefully, in company with Mr. Brown, and succeeded in obtaining additional specimens from it and in finding at that point a very interesting series of Tertiary beds. The larger part of the season, though, was spent by this expedition in collecting in the Wind River beds at the old and well known localities in the northern and northeastern parts of the basin, where the results obtained alter considerably some of the ideas previously held regarding the faunal levels of the Wind River group. The object of this article is to present briefly the results of the work in these two widely separated parts of the basin.

The Wind River Basin has an extent, roughly stated, of seventy-five miles east and west and fifty miles north and south. It is bounded on the north by the Owl Creek and Bridger ranges and by the southern end of the Big Horn Mountains, to the eastward by the low Powder River divide, on the south by the Sweetwater divide, and to the westward by the Wind River Mountains. The drainage is into the Big Horn Basin to the north through the deep, narrow Wind River cañon, cut through the Owl Creek Mountains. Except in the spring or after heavy rains nearly all of the water contained in the main drainage stream, Wind River, as it enters the cañon, is derived from the Wind River Mountains and the ranges lying to the northwest of the basin. All of the streams from the east and southwest, as well as Muddy Creek from the Owl Creek Mountains, run dry as the summer advances, except toward their sources. The central and eastern parts of the basin are very open, with low, grass-covered divides, very few buttes of any consid-

erable size, and with low escarpments along some of the main creeks. Along Wind River, above the mouth of Little Wind River, the stream has cut down through the soft Tertiary rocks so that in places steep bluffs several hundred feet in height occur. Along the foot of the mountains, especially of the Wind River range, the country is much rougher, owing chiefly to the upturning of the Mesozoic strata.

These older formations are seen only along the northern, western, and southern borders of the basin; the great central area is entirely Tertiary, the Wind River group of Hayden. Most of this exposed Tertiary is younger than the Wasatch and older than the Bridger.

Along the southern border of the basin, in the Sweetwater divide, there are over 1,000 feet of Tertiary deposits, reaching in time from the Wasatch to at least the top of the Lower Oligocene. At one time these beds undoubtedly extended out over the basin to the northward a considerable distance, possibly across to the Owl Creek and Bridger ranges. The erosion has removed all traces of them, down to the Lower Eocene, with the exception, perhaps, of the northwestern part, Crow Heart Butte in particular, where the upper levels may be of Middle Eocene age.

The earliest descriptions of the Tertiary of the basin are by Hayden, who explored it as early as 1859-60; but he did not secure vertebrate fossils of any importance. The first acquaintance with the mammalian fauna of the beds was made in 1880, when J. L. Wortman traversed the basin in a search for fossils for Professor Cope and discovered on Muddy Creek and on Alkali Creek, in the extreme northeastern part of the basin, exposures of red-banded shales and clays in which mammalian remains were fairly abundant. His collection made that year comprised about twenty-five new species, including the famous skeleton of the Eocene horse, *Eohippus venticolus*. Subsequent explorations for fossils were made by Dr. Wortman for this Museum in 1891 and 1896, by Dr. F. B. Loomis of Amherst College in 1904 for that institution, and by the writer in 1905 for the American Museum. The collections obtained by these various later expeditions were all from or near the exposures which yielded the first fossils. The formation has been examined in other parts of the basin by Dr. Wortman, the writer, and others, but it has proved to be nearly barren of vertebrate remains except in these two localities.

BEAVER DIVIDE<sup>1</sup> SECTION.

A few miles east of the stage road, where it crosses from Beaver Creek and Sweetwater River, the divide rises to a height above Beaver Creek of over 1,200 feet. From the crest of this divide to the southward the land slopes gently down to the Sweetwater; to the northward, facing the Wind River Basin, it breaks off very abruptly with a slope so precipitous in places as to be difficult of ascent. This abrupt face is maintained to the eastward along almost the whole southern border of the basin. It was examined as far east as Barrel Spring, beyond which the face of the bluff is so covered with vegetation as to largely obscure the beds. The beds of this bluff in the area examined, aggregating nearly 1,100 feet, are all Tertiary, lying nearly horizontal, and resting on the upturned edges of the Mesozoic strata. Endlich has described them,<sup>2</sup> calling the lower part Wasatch, the upper part the Sweetwater Group, and noting an unconformity of dip between the two amounting to 1° or less.

The section given below was taken, with hand-level measurements, near the western end of the bluff, at a place known as "Green Cove," about four miles east of Hailey, the old stage station on Beaver Creek, where the exposures were particularly good.

*Section through the Tertiary deposits of the Beaver Divide, about four miles east of Hailey.*

*Top of Divide.*

- |   |            |
|---|------------|
| 9. Buff and gray calcareous marls with some coarse sandstone and a little sandy shale. Marls more highly calcareous than No. 8, and toward the top weather out into hard ledges . . . . .   | ft.<br>210 |
| 8. Buff-colored calcareous marls, very uniform in nature except the lower 50 feet where the marls are interbedded with coarse sandy layers from one inch to two feet in thickness . . . . . | 330        |

*Erosion Unconformity.*

- |   |     |
|---|-----|
| 7. Coarse greenish sandstone . . . . .  | 10  |
| 6. Yellowish green and olive coarse, loosely compacted sandy stones . . . . .   | 55  |
| 5. Gray and yellowish clay . . . . .  | 27  |
| 4. Blue-gray clay and sandstone, forming a prominent ledge along the face of the bluff; weathers nearly vertical . . . . .  | 20  |
| 3. Beginning at the base of the main bluff where there is a red stratum corresponding with the one at the top of the butte in No. 2, the rock is pale yellowish brown and alternates between sandy and clayey shales, with coarse sandy beds at intervals. Some layers weather out harder, forming rounded ledges . . . . . | 165 |

<sup>1</sup> That part of the Sweetwater divide where the Lander-Rawlins stage trail passes over from Beaver Creek and Sweetwater River is known locally as Beaver Divide or Beaver Hill.

<sup>2</sup> Endlich, F. M. 11th Ann. Rept. U. S. G. Surv. Terrs., 1879, p. 110.

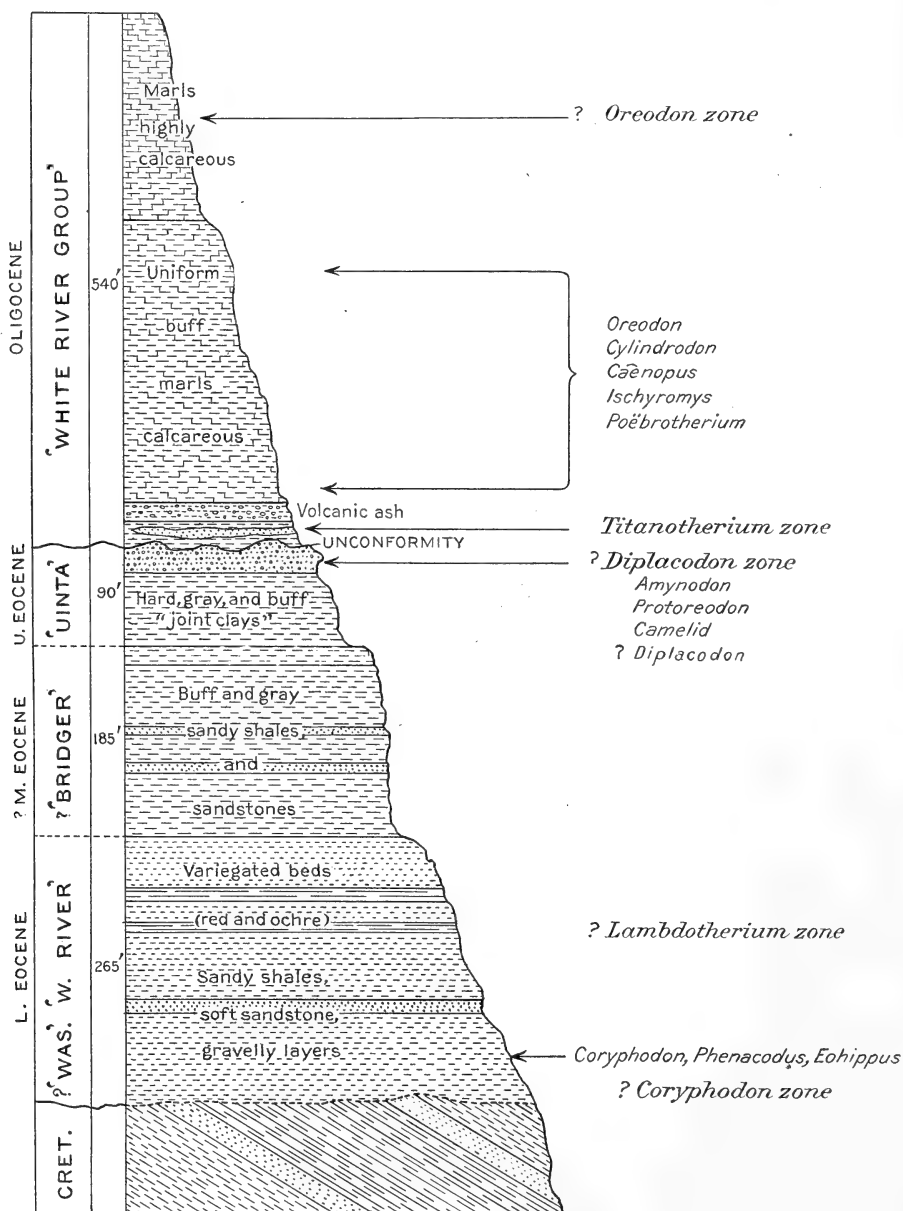
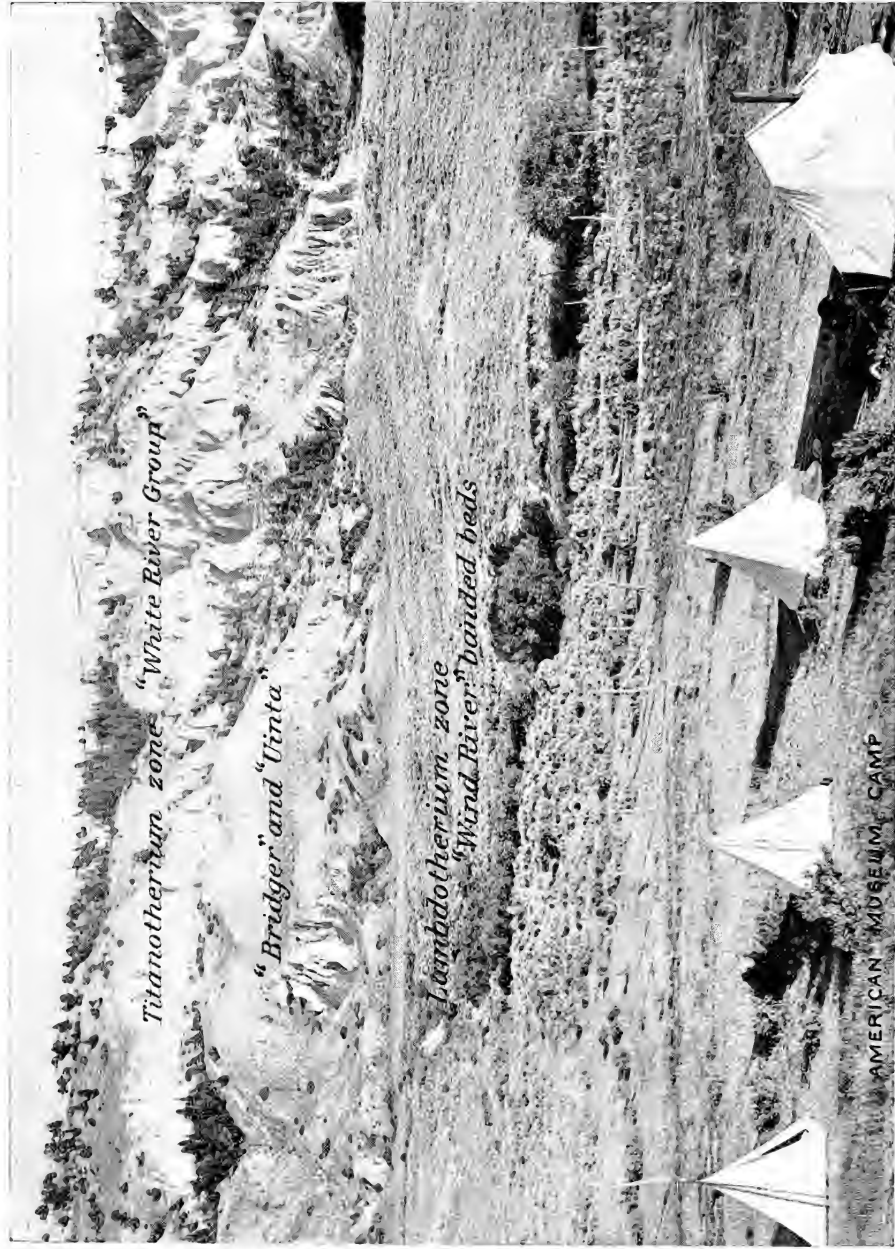


Fig. 1. Generalized section of the Tertiary of the Beaver Divide.





Escarpment of the Beaver Divide at Green Cove, near Hailey, looking south. The top of the bluff is about 900 feet above the camp.



- |    |  |            |
|----|--|------------|
| 2. | A small outlying butte is composed of alternating layers of gray and purplish clays, gray-green sandy shales and strata of coarse sand. Some of the sandy layers weather out salmon-colored . . . . .  | ft.<br>125 |
| 1. | One mile out from the foot of the bluff, and resting nearly horizontally on upturned Cretaceous, are sandy clays, becoming more sandy toward the top, and with a two-foot stratum of calcareous sandstone midway. The clays are yellowish, greenish, and purplish (Corresponding level at Barrel Spring contains ? Wasatch fauna.) | 140        |
|    | Total . . . . .  | 1,082      |
0. Cretaceous.

Lithologically, as well as faunally, the beds fall into three groups: (1) the red banded clays and coarse sands of the Lower Eocene, (2) the greenish, blue-gray and olive-colored shales, clays, and sandstones of the (?) Middle and Upper Eocene, and (3) the buff and light gray calcareous marls of the Lower Oligocene. The upper and lower groups are fairly constant in character throughout the area examined, but the middle one is variable, the various strata maintaining their character over a very limited area only. An exception to the uniformity of the Lower Oligocene is the presence, near Wagon-bed Spring, of a five-foot bed of volcanic material not observed at Green Cove, where the above section was taken. The bed is from fifty to one hundred feet above the unconformity and consists of gray ash, in which is imbedded in places numerous smooth, rounded masses of pumice an inch or two in diameter. This bed is well shown near the top of the exposures in Plates XXI and XXII.

No break in sedimentation was detected in the Eocene series, yet a careful examination by a competent stratigrapher might bring it to light. The Bridger formation in the Bridger Basin has a maximum thickness of 1,800 feet, and the only beds in this section which might be assigned to that formation are the 200 or 250 feet of unfossiliferous strata between the Lower Eocene banded beds and the layers lying immediately below the unconformity, which are unquestionably Upper Eocene.

Mammalian fossils were found on three levels, as noted in the section above. They were not at all abundant on any level nor in any locality, and it was only by painstaking and prolonged search that the number of forms listed below was obtained. The genera and species, so far as determined, from the three horizons are as follows:

WASATCH (? *Coryphodon* Zone).

*Eohippus* sp.

*Phenacodus* sp. . . . .

*Coryphodon* ?*testis*.

UINTA (? *Diplacodon* Zone).? *Diplacodon*.*Amynodon* ?*antiquus*.*Protoreodon* ?*parvus*.

Camelid, gen. nov.

WHITE RIVER (*Titanotherium* Zone).*Titanotherium* ?*heloceras*.*Hyracodon* sp.*Cænopus* sp.*Oreodon* sp.*Leptomeryx* ?*esulcatus*.*Pœbrotherium*.? *Mesodon*.*Palæolagus* ?*temnodon*.*Ischyromys* *veterior*.*Cylindrodon* *fontis*.

Of the Wasatch specimens, which were found low down in the variegated beds on Sand Draw, near Barrel Spring, the *Eohippus* and *Phenacodus* are merely isolated molar teeth and not specifically determinable; the *Coryphodon* is a front of a skull with full dentition, and a careful comparison shows it to be near to, if not identical with *C. testis* of the Big Horn Wasatch and unlike any species of this genus from the *Lambdaotherium* zone of the Wind River. The determination of these beds then, as pertaining to the *Coryphodon* zone, rests upon the identification of this one specimen, all three genera being common to both zones.

On the Uinta level the fossils came, with one exception, from Wagon-bed Spring, and were found mostly in a pale yellowish, tough, sandy clay, although a few fragments were in the base of the hard, coarse, greenish sandstone immediately overlying and at the very top of the Eocene series. The exception was a single lower molar of *Amynodon* together with a few indeterminate fragments from Barrel Spring. The exact locality of the finds at Wagon-bed Spring is the northern half of Sec. 3, Tp. 31N., R. 95 W. The *Titanotheriidae* are represented by a jaw fragment with last lower molar. It was found by a ranchman several years ago and is still in his possession and not available for exact comparison. Judging from the measurements it might pertain to *Diplacodon* or *Protitanotherium* from Uinta C, or to *Telmatherium ultimum* from Uinta B. The *Amynodon* skull agrees with the description of the type, *A. antiquus*, from Washakie B, and cannot be separated specifically from a skull in the American Museum Collection from this locality. Two specimens of *Protoreodon* seem to be referable to *P. parvus*, a species recorded in the American Museum collection from the Uinta Basin as coming chiefly from the base of Horizon C, and in the Princeton collection, according to Professor Scott, from the top of Horizon B.

The Camelid is represented by a lower jaw. Its closest affinities are with *Protylopus* from Uinta C. It is doubtful, therefore, whether this horizon is to be correlated with the true Uinta (Horizon C) or with Uinta B and its equivalent (in part) in the Washakie Basin, Washakie B.

In the Oligocene beds well preserved fossils were found sparingly throughout the area examined, chiefly in the marls from fifty to two hundred feet above the base, although the skull of *Titanotherium heloceras* was in a coarse sandstone channel deposit near the base of the beds. The small fauna resembles very much that of the *Titanotherium* Zone of Pipestone Springs, Montana, especially in the Rodentia. The *Ischyromys*<sup>1</sup> is identical with the Montana species, which Dr. Matthew has recently separated subgenerically from the species of the *Oreodon* beds of South Dakota and Colorado. The genus *Cylindrodon* has only been recorded from Pipestone Springs, the type locality, and from near Bates's Hole, Wyoming, in a locality recently explored by Mr. W. H. Reed. The beds in the latter locality are further connected with those of the former by the presence of the Insectivore *Apternodus mediocris* Matthew.<sup>2</sup> The *Titanotherium* beds of the Beaver Divide may very probably be a westward extension of those of Bates's Hole.<sup>3</sup> It would seem, at any rate, that the beds of the three localities were of contemporaneous deposition.

#### LOST CABIN SECTION.

##### *Alkali Creek Exposures (Lambdotherium Zone).*

The Wind River formation as treated by Osborn,<sup>4</sup> chiefly upon the descriptions of Hayden and Wortman and information furnished by Dr. Loomis and the writer, comprises 1,200 to 1,400 feet of sediment, which he divides into two zones, the lower, or *Lambdotherium* zone (400–500 ft.), and the upper, or *Bathyopsis* zone (800–900 ft.). The collections and studies made last season make possible some corrections in this section, as

<sup>1</sup> A fairly good skull and jaws with a considerable part of the skeleton of this genus was found. The species differs materially from the typical *Ischyromys* of the Middle Oligocene and is regarded by Dr. Matthew as typical of a distinct subgenus (Matthew, W. D., 1910. Notes on the Osteology and Relationships of *Paramys*, and the Affinities of the *Ischyromyidae*. Bull. Amer. Mus. Nat. Hist., Vol. XXVIII, p. 63).

<sup>2</sup> Matthew, W. D., 1910, On the Skull of *Apternodus* and the Skeleton of a new Artiodactyl. Bull. Amer. Mus. Nat. Hist., Vol. XXVIII, p. 33.

<sup>3</sup> Darton notes that this formation (Sweetwater of Hayden Survey) strongly resembles the White River, and that it appears to merge with the Chadron formation on the high plateau west of Alcova on the Platte River (Darton, N. H., 1908, Paleozoic and Mesozoic of Central Wyoming. Bull. Geol. Soc. Am., Vol. XIX, p. 463).

<sup>4</sup> Osborn, H. F., 1909, Cenozoic Mammal Horizons of Western North America. Bull. U. S. G. S., No. 361.

will be seen by a comparison with a new generalized section, Fig. 2. As stated before, the Wind River deposits are unfossiliferous throughout the greater part of their area, the two localities where mammalian remains have been found being along Muddy Creek, on the west side of the Wind River, and in the vicinity of Lost Cabin, particularly along Cottonwood and Alkali Creeks, on the east side. The beds exposed along Cottonwood Creek, as is shown later, do not pertain to the *Lambdotherium* zone. The Muddy Creek exposures are similar in appearance to those of Alkali Creek, contain the same fauna, and need not be mentioned separately.

The exposures along Alkali Creek are all within the *Lambdotherium* zone. It is difficult to measure the full thickness of the beds here, because they are not cut through to their base at any point; it is probably not over 500 feet, however. The exposures are chiefly in a series of isolated "pockets," extending along parallel with the creek, on both sides of it. These pockets are usually less than a mile in extent and rarely expose a thickness of more than 200 feet. The dip is slight and irregular in direction. The material of the beds is sandy shale predominating, with some sandstone and a few thin strata of clay. The clays and shales often present a banded appearance, the colors being gray, brick red, and purplish. In a typical exposure, about eight miles east of Lost Cabin, the strata were as follows:

	ft.
11. Chiefly gray (deep weathering) with five or six faint purplish bands and several thin layers of sandstone . . . . .	50
10. Dull purplish . . . . .	4
9. Gray . . . . .	15
8. Brick red . . . . .	4
7. Gray . . . . .	5
6. Brick red . . . . .	8
5. Gray . . . . .	3
4. Brick red . . . . .	3
3. Gray . . . . .	5
2. Dark red, purplish at base and rusty brown at top . . . . .	10
1. Gray . . . . .	+ 15
Total, . . . . .	122

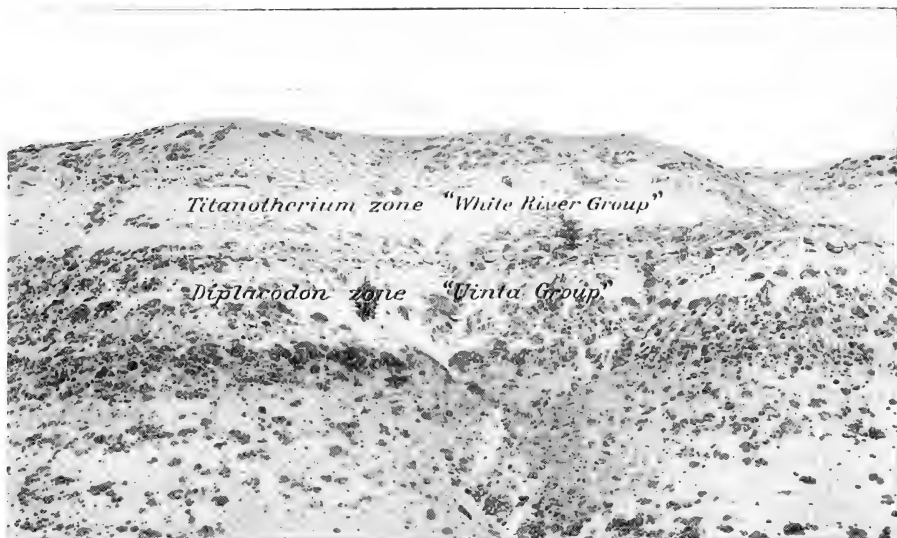
With the exception of Nos. 1 and 2 none of these strata could be traced over any considerable area. Many of them maintain their identity for but a few hundred yards along the face of the escarpment. The dark red stratum, No. 2, however, could be identified for twenty miles along Alkali Creek, partly by its peculiar coloring and partly by the presence, always, of numerous fragmentary fossils; wherever seen it was always resting on the thick gray stratum, No. 1.



View looking southwest along the northern face of the Beaver Divide from Wagon-bed Spring. The skull of *Amynodon* came from the prominence at the left in the foreground.







1. Exposure at Wagon-bed Spring, Beaver Divide, showing contact between Upper Eocene and Lower Oligocene. The skull of *Titanotherium* was from the draw in the distance.



2. Lamdotherium zone, Wind River beds. Soft yellow sandstones containing hard gray concretionary sandstones. North side of Alkali Creek, about eight miles east of Lost Cabin.



The sandstones occur either in thin strata covering only a small area, or in masses ten to twenty feet in thickness and having the appearance of channel deposits. These more massive sandstones are quite soft, pale yellow in color, and usually contain hard gray sandstone concretions, often in the form of flattened spheres or in long flat strips from one to three feet in width and a few inches in thickness. Occasionally the long concretions are subcylindrical, twenty feet or more in length, and with one end developed into a large bulb, like a thermometer tube. The long masses, wherever in place, point in an east and west direction. In Plate XXII, Fig. 2, a mass of this soft, yellow sandstone with the contained concretions is shown.

The fossils are found almost exclusively in the clays and shales, and are comparatively rare except on one or two levels; they are more abundant in areas where the red and gray banding is most pronounced. One particular stratum, the dark red one mentioned above, was fairly rich in fragmentary remains and could be depended upon to yield fossils wherever examined. Along Muddy Creek the banding is less conspicuous and fossils are more rare. In the central part of the basin the variegated beds are not observed, the shales being pretty uniformly gray or greenish, and mammalian fossils are practically absent.

Of considerable interest was the discovery in the *Lambdotherium* zone last season of specimens of the genera *Bathyopsis* and *Eotitanops*. In the absence of any definite records of levels or localities with the types or other specimens of these genera in the American Museum collection, Osborn was led to believe that they came from a higher level than the *Lambdotherium*, and which he termed the *Bathyopsis* zone, this being a part of the 1,200 feet or more of Wind River deposits which Hayden describes as occurring in the western part of the basin. Two specimens of *Bathyopsis*, one a good skull, were obtained from opposite sides of Alkali Creek, north of Wolton station. They were from the same level and were in association with *Lambdotherium*, *Heptodon*, *Eotitanops*, *Phenacodus*, etc. Of *Eotitanops* ten specimens of the two species *E. brownianus* and *E. borealis* were found on various levels along Alkali Creek, and two specimens of the latter species were obtained from Muddy Creek. It would seem that the *Bathyopsis* zone must be eliminated; it is improbable that there is any distinct faunal level of the Wind River formation above that in which *Lambdotherium* occurs. The upper part of the deposits to the west, especially near Crow Heart Butte, more probably belong to the Bridger than to the Wind River horizon, although in the absence of mammalian fossils it is impossible to say definitely.

Two other genera of interest were found in the *Lambdotherium* zone last year. They are *Meniscotherium*, previously recorded only from the Wasatch

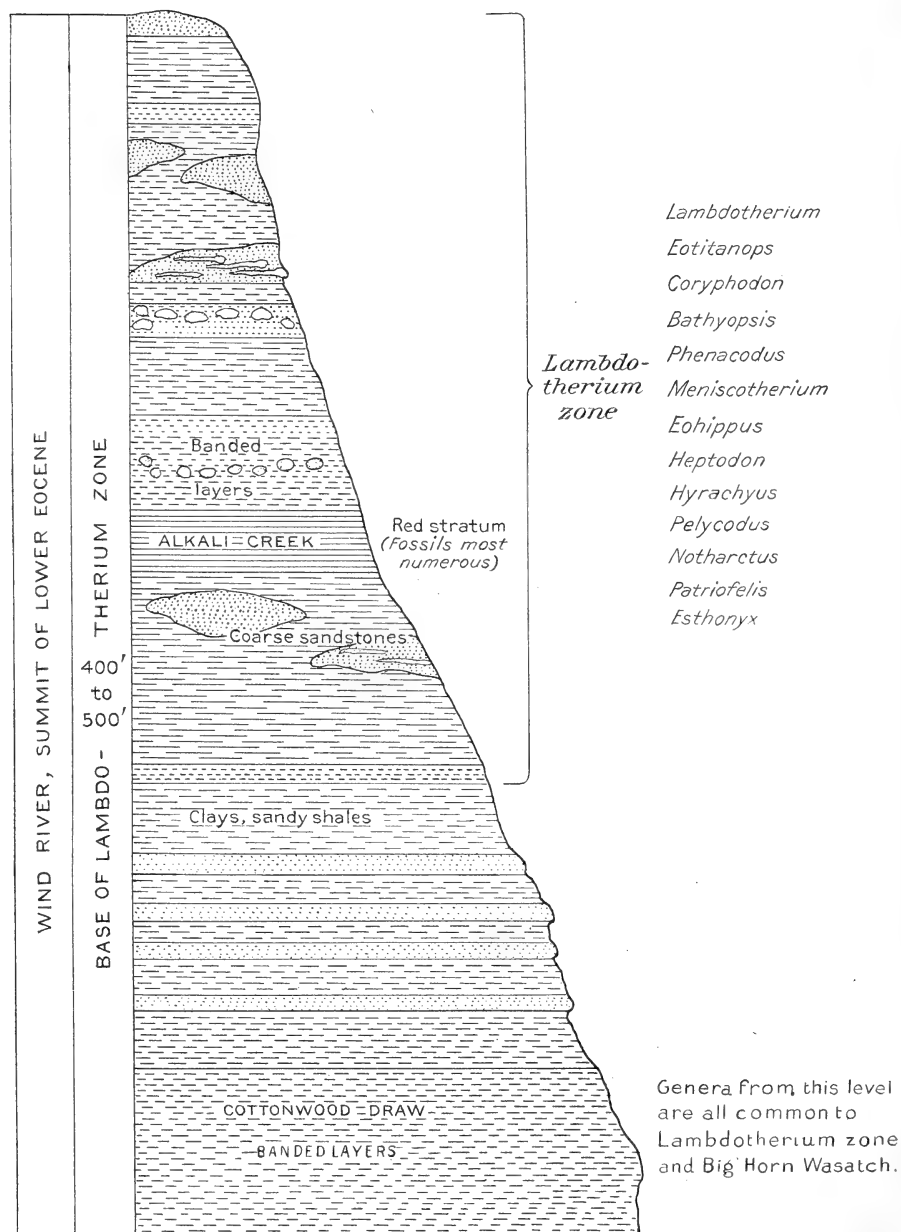
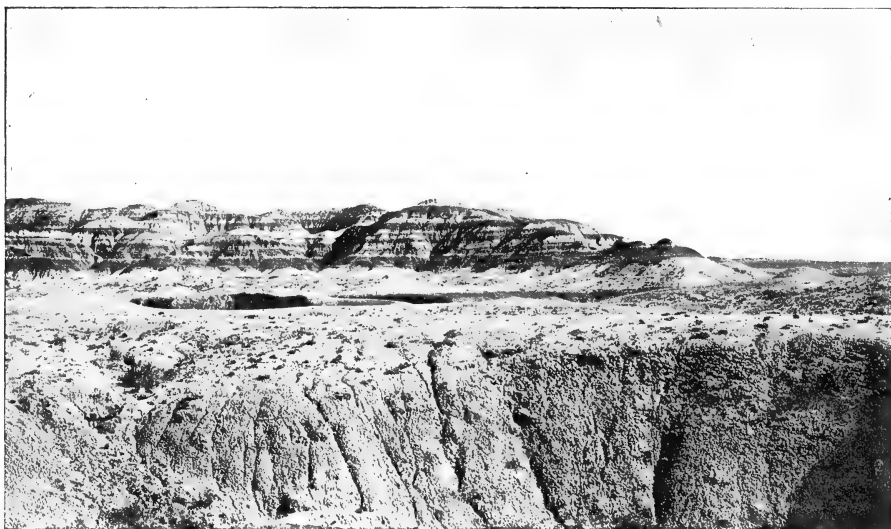
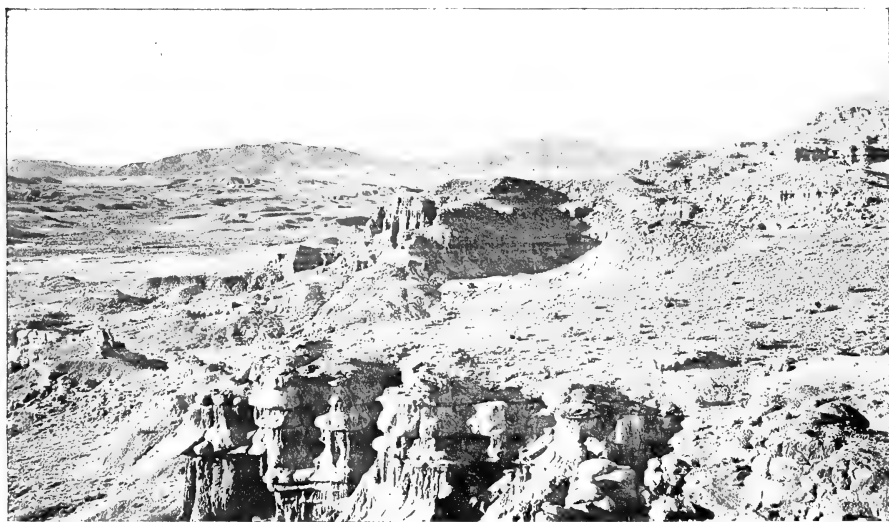


Fig. 2. Generalized section of the Lower Eocene in the vicinity of Lost Cabin.





1. Lamdothierium zone, Wind River beds. A typical exposure of red-banded layers, north side of Alkali Creek, about eight miles east of Lost Cabin.



2. Cottonwood Creek exposures, looking north, up the creek. Palaeozoic foothills of the Big Horn Range in the distance.

of New Mexico, and *Hyrachyus*, not found before below the Bridger.<sup>1</sup> The addition of these two genera to the Wind River fauna serves to show more clearly the intermediate position which this formation occupies, with a decided faunal overlapping in both directions.

*Cottonwood Creek<sup>2</sup> Exposures.*

About five miles northwest of Lost Cabin, along the south side of Cottonwood Creek, is an exposure of over 350 feet of variegated beds. They dip slightly and apparently pass under the *Lambdotherium* beds on Alkali Creek to the south. They show in section:

	ft.
Yellowish and gray sandy shales covered with heavy mantle of pebbles from the older rocks of the mountains . . . . .	50
Alternating buff sandstones (1 ft. to 5 ft. in thickness) and red and gray shales . . . . .	200
Gray and dark brick red sandy shales (red predominating) and gray sandstones . . . . .	100
Total, . . . . .	350

These exposures have a somewhat different appearance from those of Alkali Creek, due principally to the yellowish shales and numerous layers of buff sandstone in the middle and upper portions, which give the beds a much more ochreous aspect than is seen elsewhere in the Tertiary of the basin. Following up Cottonwood Creek toward the foothills of the Big Horn Mountains the sandstones and red-banded shales gradually disappear, and near the contact with the Palæozoic rocks the beds are chiefly dull-colored clays, disintegrated to a depth of two or three feet, and containing a large amount of gypsum.

Toward the mouth of Cottonwood Creek, where the exposures present the greatest thickness, fossils are to be found on nearly all levels, and are particularly abundant near the base, especially in a dark red sandy shale stratum. The remains are more fragmentary than on Alkali Creek, but are more abundant than in any other part of the basin. Dr. Loomis discovered this locality in 1904 and obtained upwards of 500 specimens, and as many more have been obtained by the American Museum parties of 1905 and 1909. A preliminary study of this fauna<sup>3</sup> shows two points of interest. *First.*

<sup>1</sup> Douglass has reported two species of *Hyrachyus*?, found associated with *Heptodon*? and *Metamynodon*?, from the Sage Creek beds of Montana. This is an extraordinary association of forms and leaves the age of these beds much in doubt (see Douglass, Earl, 1903. *New Vertebrates from the Montana Tertiary.* Ann. Carnegie Museum, VII, p. 145).

<sup>2</sup> This is the "Bridger Creek" locality of Dr. Loomis.

<sup>3</sup> The writer is indebted to Dr. Loomis for information regarding the presence or absence of certain genera in the Amherst College collection.

All of the genera from these beds are common to the *Lambdotherium* zone and to the *Coryphodon* zone of the Big Horn Wasatch. *Second*. The affinities of the species are, in general, closer to those of the latter than of the former zone. The absence in these collections of *Lambdotherium*, one of the most common forms, and of *Eotitanops*, a not uncommon genus of the Alkali Creek beds but a few miles distant, clearly indicates that these Cottonwood Creek beds belong to a faunal horizon distinct from the *Lambdotherium* zone. On the other hand, the absence of the equally common *Systemodon* of the Big Horn Wasatch makes it difficult to correlate the beds with the *Coryphodon* zone. They appear to be intermediate between the two zones, with none of the characteristic faunal features of either. Dr. Loomis states<sup>1</sup> that his collection from the Big Horn Wasatch was made on two levels, which he terms the Upper and Lower Tatman Mountain horizons. A still higher level in Buffalo Basin, immediately to the south of Tatman Mountain, yielded a small collection, in which *Lambdotherium* was the most common form although entirely absent from the Tatman Mountain levels. *Systemodon* he found particularly abundant in the Upper Tatman Mountain level and absent from the Buffalo Basin level; and he concludes that this latter level overlaps, in time, the lower Wind River, referring presumably to the *Lambdotherium* zone. Between the fossiliferous layers of Upper Tatman Mountain and Buffalo Basin are some 200 feet or more of unfossiliferous beds. During the period when these beds were laid down *Systemodon* migrated or became extinct, and *Lambdotherium* arrived; and it would seem reasonable to consider the Cottonwood Creek beds as synchronous with this series in the Big Horn Basin. The absence of *Lambdotherium* or *Systemodon* from the Cottonwood Creek strata could hardly be accounted for on geographical grounds. As to whether the beds should be considered as pertaining to the Wasatch or Wind River formations, the writer does not feel competent to say.

The extent of these exposures is small. They may be traced along Bad Water Creek, above Lost Cabin, for some distance, and probably extend considerably to the westward of Bridger Creek, but always lie between the *Lambdotherium* beds and the older rocks of the foot hills to the north. It seems not unlikely that these beds may be of the same age as those at the base of the Beaver Divide section.

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<sup>1</sup> Loomis, F. B., 1907, The Origin of the Wasatch Deposits, Amer. Jour. Sci., Vol. XXIII, p. 356.





Map of the ...



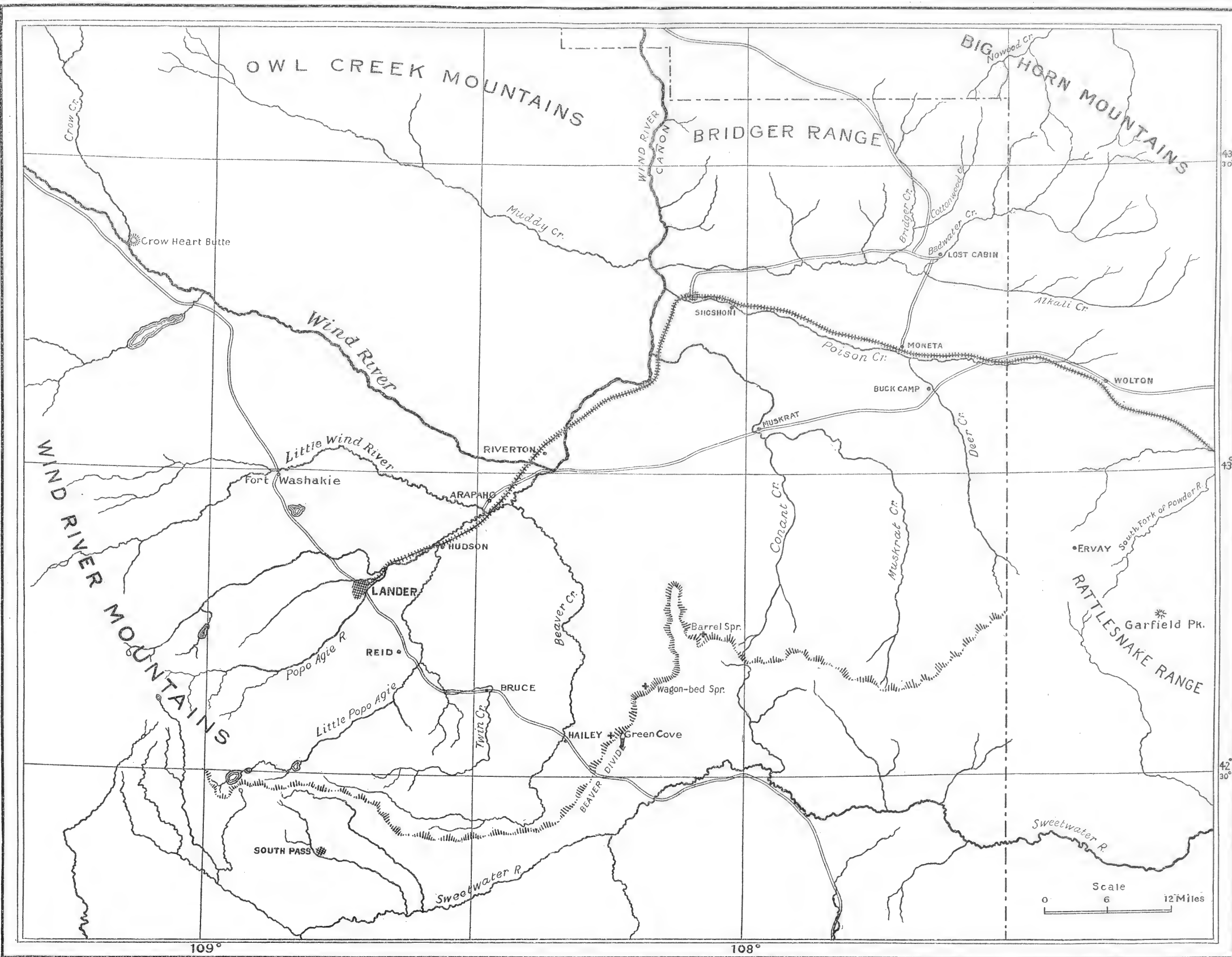


Fig. 3. Sketch map of the Wind River Basin. Based mainly on a map of Fremont County, by N. F. Brown.



## SUMMARY.

1. The Wind River Basin is covered throughout the greater part of its area with beds of the Wind River group, pertaining to the *Lambdotherium* zone.

2. Mammalian remains are extremely rare or absent from these beds except in two localities in the northern and northeastern part of the basin, viz., along Alkali Creek and between Muddy Creek and the Owl Creek Mountains.

3. Lying along the northern border of the Tertiary deposits in the northeastern corner of the basin, between the foot hills and the *Lambdotherium* beds, apparently older than the latter and with the best exposures along Cottonwood Creek, is a series of strata of 350 feet or more, containing a fauna intermediate between the *Lambdotherium* zone and the *Coryphodon* zone of the Big Horn Wasatch, the genera being all common to both zones.

4. Along the southern border of the basin, on the divide between Sweetwater River and Beaver Creek, there is exposed a thickness of 1,100 feet of Tertiary, a remnant of deposits which undoubtedly extended over a large part of the basin at one time. Three distinct faunal levels, as indicated by mammalian fossils, are exhibited, Lower Eocene, Upper Eocene, and Lower Oligocene, the levels being correlated with (1) the ?*Coryphodon* Zone of the Wasatch, (2) the ?*Diplacodon* Zone of the Uinta, and (3) the *Titanotherium* Zone of the White River. An unconformity exists between the Eocene and Oligocene, but no break in sedimentation was detected in the Eocene series.

5. Between the *Coryphodon* and *Diplacodon* levels are several hundred feet of unfossiliferous beds, the lower part of which pertain probably to the *Lambdotherium* zone of the Wind River group, and the upper part possibly to the Middle Eocene faunal zones of the Bridger Basin.

## NEW EOCENE MAMMALS FROM THE WIND RIVER BASIN.

In the collection made by the American Museum party in the Wind River Basin in 1909 are three new genera of mammals; one from the newly discovered Upper Eocene locality, and the other two from the *Lambdotherium* beds of Alkali Creek. The present opportunity is embraced to put these new forms on record.

## Family CAMELIDÆ.

**Camelodon arapahovius** gen. et sp. nov.

*Type.* The left ramus of a jaw (Amer. Mus. Coll. No. 14604) with  $p_2$ - $m_3$  in good preservation. From the Uinta beds (Diplacodon zone) of the Beaver Divide, near Hailey, Wyoming. Amer. Mus. Exped. 1909.

*Measurements.*

	mm.
$P_2$ - $m$ . . . . .	51.
$M_1$ - $m_3$ . . . . .	27.5
$M_3$ long. diam. . . . .	12.5
$M_3$ transv. . . . .	5.3
Diastema between $p_2$ and $p_3$ . . . . .	4.8
Depth of ramus at $m_2$ . . . . .	12.

An extremely slender-jawed type of selenodont artiodactyl with the teeth, especially the premolars and the third molar, much compressed, and *with a long diastema between the second and third premolars*, the latter character not being observed in other Uinta genera of this group. The second and third premolars are rather simple, compressed, and trenchant. Each has a long posterior crest and a shorter, more abrupt anterior one. On each tooth, but more marked on  $p_3$ , there is also a rudimentary internal posterior crest running backward and somewhat inward

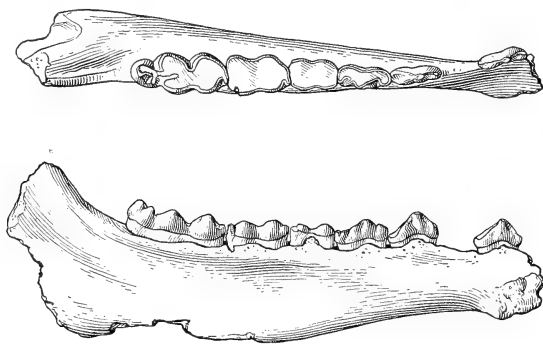


Fig. 4. *Camelodon arapahovius*, lower jaw, superior and internal views, nat. size. Type specimen, No. 14604, Uinta beds, Beaver Divide, Wyoming.

from the tip of the protocone, and enclosing a long, narrow valley between it and the external posterior crest, a character well shown in the type of *Leptotragulus propectus* Matthew from the Titanotherium beds of Pipestone Springs, Montana; on  $p_3$  the posterior and anterior basal cusps are barely indicated. In addition to strong fore and hind basal cusps there is a large cusp on the posterior inner face of the main cusp or protocone and a very small one on the inner side of the posterior basal cusp. The first and second molars are too much worn to show important characters. The

last molar is very long and narrow, with well rounded outer crescents and a strong fifth lobe with a median ridge and a small cusp on its inner side, as in *Protylopus*. There is a mental foramen below the second premolar. The symphysis extends backward to the posterior edge of the second premolar.

This genus shows strong resemblances to both *Leptotragulus* and *Protylopus*, especially in the premolar construction, and for that reason is placed in the Camelidæ. It differs from *Leptotragulus* in the more simple  $p_2$  and  $p_3$  and the more complicated  $p_4$ . From *Protylopus* it is distinguished by the more selenodont character of the molars and the greater complication of  $p_4$ . *Leptomeryx* differs in having strong anterior and posterior basal cusps on  $p_2$  and  $p_3$ , a broader  $p_4$ , and more highly specialized molars. *Hypertragulus* resembles the present genus in having a diastema back of  $p_2$ , but the premolars are much narrower antero-posteriorly, with high, sharp, pointed cusps, while in *Camelodon* these teeth are broad, with low, blunt cusps.

#### Family ANAPTOMORPHIDÆ.

##### *Shoshonius cooperi* gen. et sp. nov.

*Type.* A right maxilla with  $p^3$ - $m^3$ , unworn, and finely preserved (Amer. Mus. Coll. No. 14664). From the Wind River beds (Lambdotherium zone) of Alkali Creek, near Lost Cabin, Wyoming. Collected by Mr. C. Forster Cooper, Amer. Mus. Exped. 1909.

##### Measurements.

	mm.
$P^3$ - $m^3$ . . . . .	8.7
$M^1$ - $m^3$ . . . . .	5.7
$P^4$ tr. diam. . . . .	2.3
$M^2$ . . . . .	2.3
$M^3$ . . . . .	2.7

Distinguished at once from the other genera of this family, in which the upper dentition is known, by the presence on all three molars of a mesostyle. The third and fourth premolars are of equal size and smaller than the first molar; they have the usual Anaptomorphid construction of a large outer conical cusp and a smaller subconical inner cusp. A well defined ridge extends from the apex of the inner cusp to the external anterior angle of the tooth, which bears a diminutive parastyle. Of the molars the second is the largest, the first a trifle smaller, especially in transverse diameter, and the third somewhat smaller

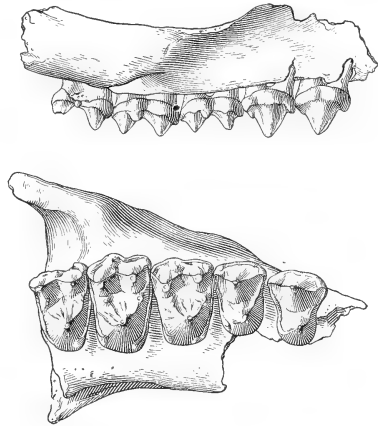


Fig. 5. *Shoshonius cooperi*, upper jaw, external and crown views,  $\times 4$ . Type specimen, No. 14664, Wind River beds, Wyoming.

than the first but not showing the amount of reduction seen in *Anaptomorphus homunculus*. In each tooth the para- and metacones are small and of nearly equal size; and the single inner cusp, the protocone, is larger and conical. Protoconules and metaconules are clearly indicated on all three teeth. Parastyle very weak on  $m^1$ , but increases in strength to  $m^3$ . The mesostyle is small on  $m^1$ , strong on  $m^2$ , and on  $m^3$  the other edge of the tooth is broken, but a portion of the mesostyle is left, indicating that it was at least as large as on  $m^1$ . There are two small cusps also on the lingual side of each molar, at the postero-internal and antero-internal angles. The postero-internal cusp is practically absent on  $m^3$ , largest on  $m^1$ , and the antero-internal is largest on  $m^2$ . These lingual cusps are much weaker than those seen in the first and second molars of the Bridger *Hemicodon*. The lower rim and floor of the orbit are preserved, and are similar to the corresponding parts in *A. homunculus*.

There are no additional specimens in our collection which can be referred to this genus. The types of nearly all Anaptomorphids are lower jaws, and with some of the genera upper teeth have not been found in certain association with lower teeth. Such discoveries might unite the present genus with one already described.

#### Family LEPTICTIDÆ.

##### *Parictops multicuspis* gen. et. sp. nov.

*Type.* Lower jaws, with  $p_2$ - $m_3$  preserved and roots of anterior teeth, and a few skeleton fragments (Amer. Mus. Coll. No. 14741. From the Wind River beds (Lambdotherium zone) on Alkali Creek, Wind River Basin, Wyoming. Amer. Mus. Exped. 1909.

##### *Measurements.*

	mm.
$I_1$ - $m_3$ (approx.) . . . . .	31.
$M_1$ - $m_3$ . . . . .	9.5
$P_2$ long diam. . . . .	3.5
$P_3$ " " . . . . .	4.5
$P_4$ " " . . . . .	4.
$P_2$ tr. " . . . . .	1.4
$P_3$ " " . . . . .	1.8
$P_4$ " " . . . . .	2.3
Depth of ramus at $m_2$ . . . . .	7.8

A genus closely related to *Palaeictops* Cope. A comparison with the lower jaw of the type of *P. bicuspis* shows the molars and the fourth premolar to be almost identical in construction in the two specimens. In the second and third premolars, however, generic differences are shown. The characters of the present genus are: Incisors three, of about equal size; canines considerably larger than incisors and elliptical in cross section at the base of the enamel;  $p_1$  single-rooted, and intermediate in size between the canines and incisors;  $p_{2-3}$  large, highly trenchant, blade-like teeth, with the cusps much compressed, and all set in the median line; in



*Palæictops* these teeth are simple, moderately compressed, pointed teeth, lacking the broad, flattened cutting blade of the crown in this genus;  $p_2$  has four cusps, the protocones with two small cusps placed high up on its anterior and posterior edges, and a small posterior basal cusp;  $p_3$  is a considerably larger tooth than  $p_2$ , and differs in cusp arrangement in having the small anterior cusp placed about half way up on the anterior edge of the protocone instead of near the apex as in  $p_2$ . The posterior basal cusp is proportionately larger than in  $p_2$  and bears directly in front a tiny accessory cusp. The fourth premolar is molariform, but differs from the molars in having

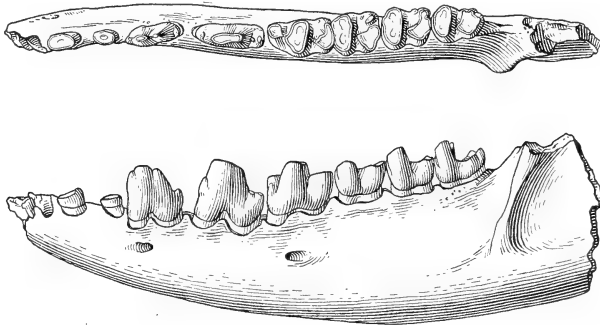


Fig. 6. *Parictops multicuspis*, lower jaw, superior and external views.  $\times \frac{1}{2}$ . Type specimen, No. 14741, Wind River beds, Wyoming.

the anterior cusp of the trigonid lower and considerably isolated from the other two. In the molars the antero-posterior diameter increases slightly from  $m_1$  to  $m_3$ . The pattern is similar in all three teeth. There is a high trigonid and a broad talonid which bears three large cusps and a fourth very diminutive one on the inside. There are two mental foramina, one below  $p_2$ , the other below  $p_4$ . The ramus is of moderate depth and compressed. The symphysis is long, extending back to the third premolar. There is a very short diastema between the canines and  $p_1$ .

The genus and species are represented in the collection by the type only.



# Article XXII.—THE NORTH AMERICAN SPECIES OF *AULACIDEA* AND THEIR GALLS.

BY WILLIAM BEUTENMÜLLER.

## PLATES XXIV–XXVI.

The present paper is the ninth installment of a series of papers on North American Cynipidæ and their galls, published by me in the Bulletin of the Museum of Natural History.

### *Aulacidea Ashmead.*

*Cynips* (in part) BOUCHE, Natur. Ins., 1834, p. 164.

*Aylax* (in part) HARTIG, Zeitsch. für Ent., Vol. II, 1840, p. 195.

*Aulax* HARTIG, Zeitsch. für Ent., Vol. IV, 1843, p. 412; SCHENCK, Jahrb. Ver. Naturk. Nassau, Vols. XVII–XVIII, 1863, p. 216.

*Aulacidea* ASHMEAD, Psyche, Vol. VIII, 1897, p. 68; *ibid.*, Vol. X, 1903, p. 211; KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 92; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 75.

*Pseudaulax* ASHMEAD, Psyche, Vol. X, 1893, p. 213.

Closely allied to the genus *Aylax*, but the radial area is distinctly closed at the costal margin. Otherwise the characters are the same.

*Type: Aulax mulgediicola* Ashmead (= *Aulacidea bicolor* Gillette).

### *Aulacidea tumida* (Bassett).

*Aulax tumidus* BASSETT, Trans. Am. Ent. Soc., Vol. XVII, 1890, p. 92; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist., Vol. IV, 1892, p. 263; Journ. Am. Mus., Vol. IV, 1904, p. 109, fig. 46; Ins. Galls Vicin. N. Y., 1904, p. 23, fig. 46.

*Aulax tumida* DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 125.

*Aulacidea tumida* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 96; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 76.

*Aulax timidus* JARVIS, Rep. Ent. Soc. Ont., 1906 (1907), p. 72.

*Aulax sonchicola* ASHMEAD, Proc. U. S. Nat. Mus., Vol. XIX, 1896, p. 134.

*Aulacidea sonchicola* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 96; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 76.

*Aulacidea solidaginis* GIRAULT, Ent. News, Vol. XIV, 1903, p. 323.

*Female.* Head black, subopaque, subquadrate, facial ridge very broad, face, vertex and sides finely granulose. Antennæ 13-jointed, last joint very long, reddish brown. Thorax black with closely appressed microscopic whitish hairs, subopaque, finely and distinctly reticulated, collar very broad. Pleuræ finely aciculated. Me-

dian groove from the scutellum short and distinct. Parapsidal grooves continuous, fine and distinct, almost parallel until close to the scutellum where they slightly converge. Anterior parallel lines indistinct and short. Grooves at base of wings distinct, but not conspicuous. Scutellum black, rugose, with two large and shallow foveæ at the base. Abdomen inflated, reddish brown, semitranslucent, smooth and polished, piceous at the base dorsally. Legs reddish brown, microscopically pubescent. Wings somewhat dusky hyaline, veins yellowish brown and heavy, cubitus scarcely reaching the first cross-vein. Areolet more or less distinct, or wanting. Length, 2-3 mm.

*Male.* Similar to the female, black, except the legs and antennæ, which are reddish brown. Antennæ 14-jointed, third joint short and curved. Areolet more distinct. Length, 1.75-2.50 mm.

*Gall.* (Plate XXIV, Figs. 1-8.) On the stalks of wild lettuce (*Lactuca canadensis*), usually near the summit and often in the panicle, and then covered with short flower stalks. Polythalamous. More or less rounded or elongate irregular swellings of various shapes. Green when fresh and brown when old and dry. Inside (Fig. 8) the gall is pithy and contains numerous larval cells. Length, 25-75 mm.

*Habitat:* Canada; New England and Middle States, southward and westward.

I have examined the types of *Aulacidea sonchicola* Ashmead and *Aulacidea solidaginis* Girault and I cannot find any distinctive characters to separate them from *Aulacidea tumida*. *A. sonchicola* was bred from galls on the stems of the sow thistle (*Sonchus oleraceus*), a plant naturalized from Europe and closely allied to *Lactuca*. *A. solidaginis* was bred from galls on the stems of goldenrod, taken by Mr. Girault at Blacksburg, Virginia. The galls of the latter were collected in the winter when the plants of *Lactuca* and goldenrod may be readily mistaken for one another and I am much inclined to believe that the galls of *A. solidaginis* occur on *Lactuca* and not goldenrod. The galls of *A. tumida* are very variable in shape and the one figured on Plate XXIV, Fig. 2, was taken by me on *Lactuca canadensis* and it is a counterpart of the gall of *A. solidaginis* figured by Mr. Girault.

### ***Aulacidea podagræ* (Bassett).**

*Aulax podagræ* BASSETT, Trans. Am. Ent. Soc., Vol. XVII, 1890, p. 91; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 123.

*Aulacidea podagræ* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, 57.

*Female.* Head black, finely reticulated or punctate, facial elevation distinct. Antennæ dark reddish brown becoming darker terminally, 13-jointed. Thorax black, subopaque, very finely and evenly wrinkled or reticulated; median groove from the scutellum very fine and extending to about the middle of the thorax. Anterior parallel lines short and very indistinct. Parapsidal grooves continuous, fine and almost parallel; grooves over the base of the wings present, but inconspicuous. Scutellum black, rugose, with the two foveæ at the base large, rugulose and

somewhat shining. Abdomen black or pitchy brown and polished. Legs reddish or yellowish brown. Wings hyaline, iridescent, veins dark brown, cubitus fainter. Areolet present and well defined. Length, 2-2.50 mm.

*Male.* Very similar to the female in color and marking, but somewhat smaller. It differs only by having the abdomen smaller, and 14-jointed antennæ with the third joint curved and incised.

*Gall.* (Plate XXV, Figs. 1-4.) In the pith of the stalks of wild lettuce (*Lactuca canadensis*). Polythalamous, sometimes causing a swelling of the stalk.

*Habitat:* Canada; New England and Middle States, south and westward.

The adult is closely allied to *A. tumida*, but differs from this species by being darker, and by the more evenly wrinkled thorax and more rugulose scutellum. The gall varies from small pits in the pith of the stalk without any traces of swellings externally, to swellings measuring from 10 to 300 mm. in length and from 10 to 60 mm. in diameter.

### **Aulacidea bicolor (Gillette).**

*Aulax bicolor* GILLETTE, Bull. Ill. St. Lab. Nat. Hist., Vol. III, 1891, p. 201; DALLA TORRE, Cat. Hymen., Vol. II, 1893, p. 120.

*Aulacidea bicolor* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 75.

*Aulax mulgedicola* ASHMEAD, Proc. U. S. Nat. Mus., Vol. XIX, 1896, p. 133.

*Aulacidea mulgedicola* ASHMEAD, Psyche, Vol. X, 1903, p. 211.

*Aulacidea mulgedicola* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95.

*Aulacidea mulgedicola* DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 75

*Female.* Head black, shading into rufous towards the mouth parts or wholly black, finely wrinkled and pubescent, face with a median ridge. Antennæ 13-jointed, dark rust brown. Thorax black, shoulders sometimes rufous, mesothorax finely sculptured, opaque and clothed with sparse recumbent pubescence. Parapsidal grooves distinct and rather deep. Median groove very short and broadened at the scutellum so as to be almost triangular. Anterior parallel lines very fine and short. Lateral grooves appear as polished lines. Pleuræ densely and rather coarsely aciculate. Scutellum black, with two small, shallow, oblique foveæ, the surface rather coarsely rugose. Abdomen ovate, rufous or yellowish red, smooth and shining. Legs reddish. Wings hyaline, radial cell closed. Areolet present. Length, 1.50-2.50 mm.

*Male.* Abdomen pitchy brown. Antennæ 14-jointed. Areolet very small or scarcely evident. Length, 1-2 mm.

*Gall.* (Plate XXV, Fig. 5.) Consists simply of a thin-shelled larval cell imbedded in the pith of wild lettuce, *Mulgedium* (*Lactuca*) *acuminata*, and *Lactuca canadensis*. Usually there are numerous cells crowded together side by side in the pith, and externally the stem or stalk shows no apparent gall, swelling or deformation, although occasionally a slight swelling of the stalk occurs.

*Habitat:* Massachusetts; Connecticut; New York; New Jersey; District of Columbia; North Carolina; Illinois.

The types of *Aulacidea bicolor* Gillette are in the Illinois State Laboratory of Natural History and were sent to me for examination by Mr. C. A. Hart. I have also seen the types of *Aulacidea mulgédiicola* Ashmead in the United States National Museum and they are the same as *A. bicolor*.

### *Aulacidea nabali* (Brodie).

*Aulax nabali* BRODIE, Can. Ent., Vol. XXIV, 1892, p. 12; FYLES, Can. Ent., Vol. XXIX, 1897, p. 79.

*Aulacidea nabali* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95.

*Male and female.* Head black, and finely punctate. Antennæ black or very dark piceous, 13-jointed in the female, 14 in the male. Thorax black, finely and evenly punctate, subopaque. Parapsidal grooves distinct, widely separated and slightly converging at the scutellum. Median groove from the scutellum extending to about the middle of the mesothorax. Anterior parallel lines short and indistinct. Pleuræ black, finely striate. Scutellum black, evenly rugose, foveæ at the base deep and distinct. Abdomen rufous or rufo-piceous, usually somewhat darker in the male. Legs rufous, somewhat paler than the abdomen. Wings hyaline, radial area closed. Areolet large. Veins brown.

Length, of male 1-2 mm.; of female 1.73-2.75 mm.

*Gall.* (Plate XXVI, Figs. 1-7). At the base of the stems of *Nabulus altissima*, usually in masses surrounding the stem, often extending down on the main root, rarely on the main fibres of the roots, usually about an inch under the ground, sometimes partly above the ground. Polythalamous. Roughly spherical, usually aggregated in irregular cylindrical masses of 4 to 14, resembling small knotty artichokes or irregular white potatoes. The anterior of the gall has the appearance and consistence of a raw potato. When mature, in September, the gall retains its pale appearance through the winter, but in spring darkens in color. When dry the interior presents the appearance of corky fibrous folds, with numerous larval cells. Diameter 5 to 10 mm.

*Habitat:* Canada (Toronto); Massachusetts; New York; New Jersey.

A fine lot of galls of this species, collected at Magnolia and North Brookfield, Massachusetts, were sent to me by Miss Cora H. Clarke and Mr. Frank Dobbin. The specimens were obtained in September and October, and the adults emerged late in December.

### *Aulacidea ambrosiæcola* (Ashmead).

*Aulax ambrosiæcola* ASHMEAD, Proc. U. S. Nat. Mus., Vol. XIX, 1896, p. 134.

*Aulacidea ambrosiæcola* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 75.

*Male and female.* "In size and structure, and general appearance this species comes remarkably close to *A. mulgédiicola*; but with a very high power lens the sculpture appears very distinct, the punctuation being slightly transverse. There is a short acute median groove between the parapsidal grooves posteriorly, the scutel-

lar foveæ are not so sharply defined, while the color of the legs and abdomen will at once distinguish it from that species. In the female the legs and abdomen are reddish yellow, while the abdomen in the male is black. Length, 2-2.20 mm." (Ashmead).

*Habitat*: Missouri (Kirkwood).

Little is known regarding this species. The types are in the United States National Museum. Dr. Ashmead states that the insects from which his description was made, were received from Miss Murtfeldt with the statement that they were parasitic on a lepidopterous gall-maker on *Ambrosia*. Mr. Ashmead believes that there is some mistake in this statement as the flies are unquestionably true gall-makers and evidently form larval cells in the pith of *Ambrosia*, not observed by Miss Murtfeldt; and, moreover, their structural characters prove conclusively that they are not parasitic. It is also quite probable that the Lepidopteron is inquiline in the galls produced by this species. I have seen the types and believe the species will ultimately prove to be nothing more than a variety of *Aulacidea bicolor*.

#### *Aulacidea harringtoni* (Ashmead).

*Aulax harringtoni* ASHMEAD, Trans. Am. Ent. Soc., Vol. XIV, 1887, p. 146; DALLA TORRE, Cat. Hymen. Vol. II, 1893, p. 12.

*Aulacidea harringtoni* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2, Vol. X, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 75.

*Female*. Head and thorax black, rugose, the sculpture being somewhat longitudinal. Antennæ 14-jointed, brown, reaching the tip of the abdomen, joints 3, 4 and 5 very nearly equal in length. Parapsidal grooves distinct. Median groove slight and extending from the scutellum not quite to the middle of the mesothorax. Scutellum rounded with two sharply defined, oblique foveæ at the base. Legs and abdomen reddish. Wings hyaline with distinct brown veins, a closed marginal cell, a rather large areolet and the cubital cell open at the base. Length, 3.25 mm.

*Habitat*: Canada (Ottawa).

The type, a single female, is in the United States National Museum. The thorax is somewhat shining, with the punctation very minute. The parapsidal grooves sharply defined, and the median groove short and not extending to the middle of the thorax. The anterior parallel lines are extremely fine and scarcely evident, and the scutellum is evenly rugose. The abdomen, legs, and two basal joints of the antennæ are red brown, and the remaining joints of the latter are black. The gall is unknown.

#### *Aulacidea cavicola* (Ashmead).

*Aulax cavicola* ASHMEAD, Proc. U. S. Nat. Mus., Vol. XIX, 1896, p. 134.

*Aulacidea cavicola* KIEFFER, Bull. Soc. Hist. Nat. Metz, ser. 2., Vol. X, 1902, p. 95; DALLA TORRE and KIEFFER, Gen. Ins. Hymen. Fam. Cynip., 1902, p. 75.

*Female.* "This species bears a very close resemblance to *A. mulgediicola*, but differs as follows: The face is without the median ridge; the short median groove of the mesothorax is longer, extending not quite to the middle; there is a distinct groove on the shoulders, extending from the base forward to at least half their length; the second and third abdominal segments dorsally at base are very dark, almost black, making the abdomen appear as if banded, while the basal joint of the posterior tarsi is longer than it is in *A. mulgediicola*. Length, 2.40 to 3 mm." (Ashmead).

*Habitat:* Missouri (Indian Cave).

The types, two females of this species are in the United States National Museum, and nothing concerning the gall is known. I have examined the types, but am not prepared to give an opinion upon them without further study. I am, however, inclined to believe that the species will prove to be the same as *Aulacidea tumida*.

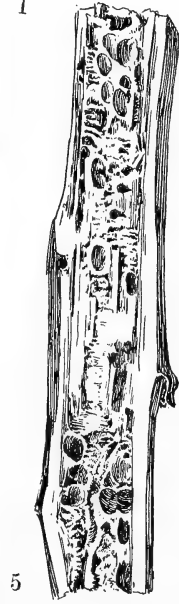
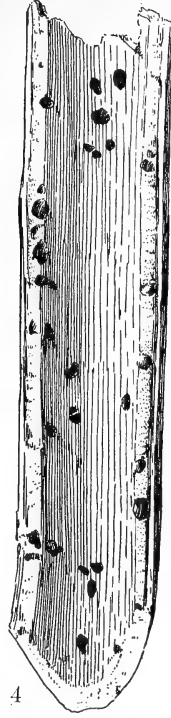




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Figs. 1-8. *Aulacidea tumida* (Bassett).



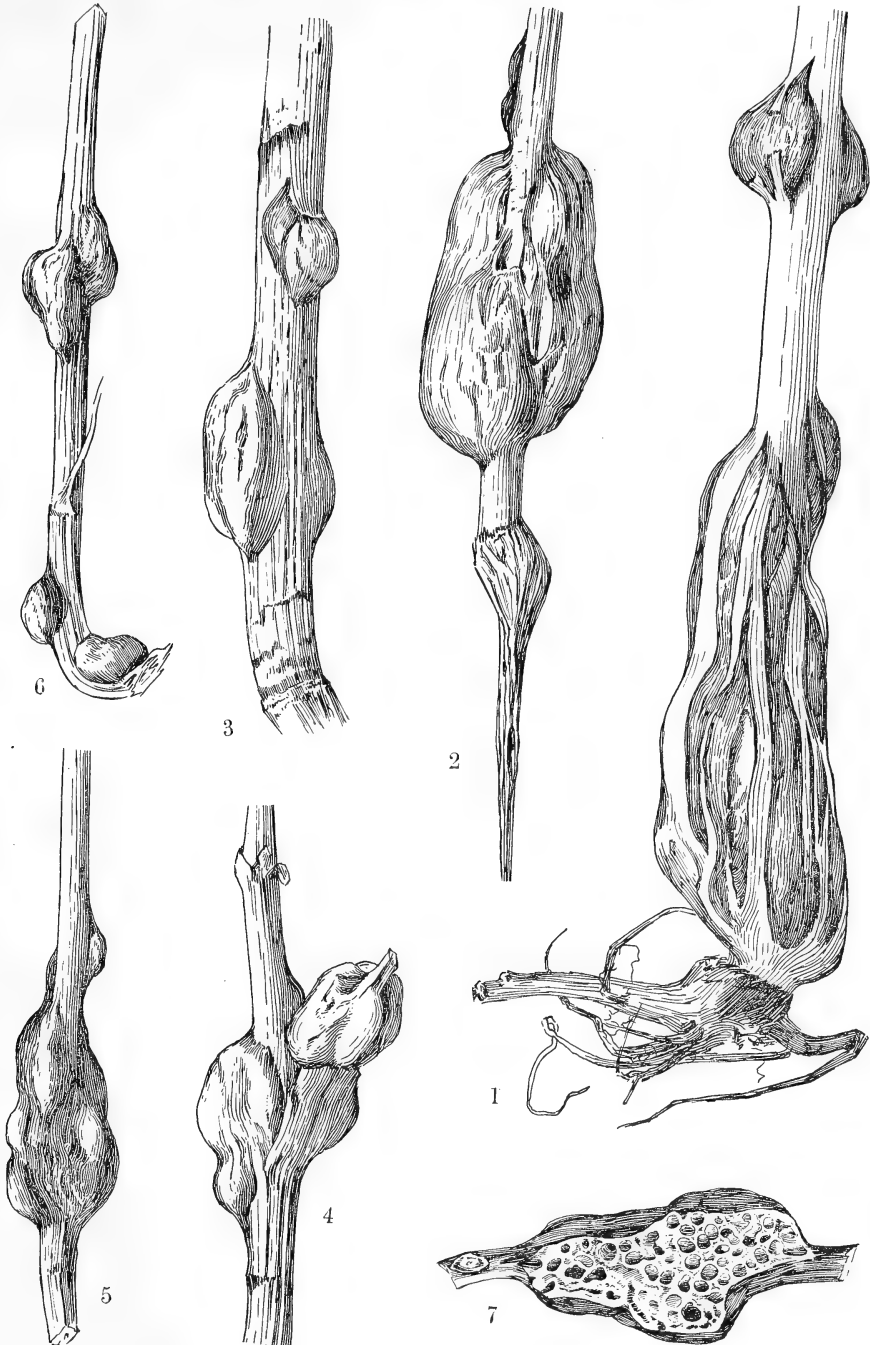


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Figs. 1-4. *Aulacidea podagra* (Bassett).

Fig. 5. *Aulacidea bicolor* (Gillette).





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Figs. 1-7. *Aulacidea nabali* (Brodie).



Article **XXIII.**—THREE NEW GENERA OF MYRMICINE ANTS  
FROM TROPICAL AMERICA.<sup>1</sup>

BY WILLIAM MORTON WHEELER.

In a collection of neotropical ants comprising several hundred specimens, loaned me for study by the authorities of the United States National Museum, I find the three following species, each of which represents a genus hitherto undescribed.

**Nescmyrmex** gen. nov.

*Female.* Allied to *Leptothorax*. Body small, slender. Head longer than broad, convex above in the middle, flattened below, broader behind than in front, and strongly impressed in the region of the eyes, which are rather large and in front of the middle. Mandibles moderately convex, dentate. Clypeus small, feebly convex, with rounded and projecting anterior border. Frontal area elongate-triangular, rather indistinct; frontal carinae short but well-developed, frontal groove absent. Antennae 11-jointed, funiculus with a 3-jointed club. Thorax long and narrow, flattened above and on the sides, with acute and prominent humeri. Mesonotum subtriangular, narrowed to a rounded point anteriorly. Epinotum dentate; episternal angles rounded. Petiole not pedunculate, with an anteroventral tooth and well developed dorsal node. Postpetiole depressed, constricted behind. Gaster short, elliptical, flattened above, more convex beneath, the first segment very large; sting well developed. Legs stout; femora clavate, incrassated; middle and hind tibiae without spurs. Wings long, minutely hairy, with large apterostigma, one cubital cell, a small closed radial and no discal cell. Hairs on body short, sparse, erect and clavate; pubescence closely appressed.

**Nesomyrmex clavipilis** sp. nov.

(Fig. 1.)

*Female.* Length 2.8 mm.

Head with feebly and broadly excised, marginate posterior border; posterior corners and cheeks rounded. Mandibles 4-toothed. Antennal scape reaching to about half the distance between the eye and the posterior corner of the head. Funiculus much longer than the scape; its first joint as long as the 3 succeeding joints together; joints 2-7 broader than long; joints 8 and 9 subequal, together decidedly shorter than the terminal joint. Thorax somewhat narrower than the head, narrower behind than in front, with steep sides. Epinotum in profile with short, stout, blunt teeth and subequal base and declivity, the former feebly convex, the latter

<sup>1</sup> Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 23.

flattened. Petiole longer than broad, broadest in the middle; in profile with a moderately high node in the middle, its upper surface depressed, its anterior and posterior declivities subequal and slightly concave. Postpetiole from above transversely elliptical, twice as broad as long and one-third again as broad as the petiole; in profile convex above in front, flattened behind, below with a prominent transverse welt. Gaster considerably larger than the head, its anterior border slightly angular on the sides.

Body, including the mandibles, very finely and densely punctate, opaque; legs and upper surface of gaster somewhat shining and more sparsely punctate.

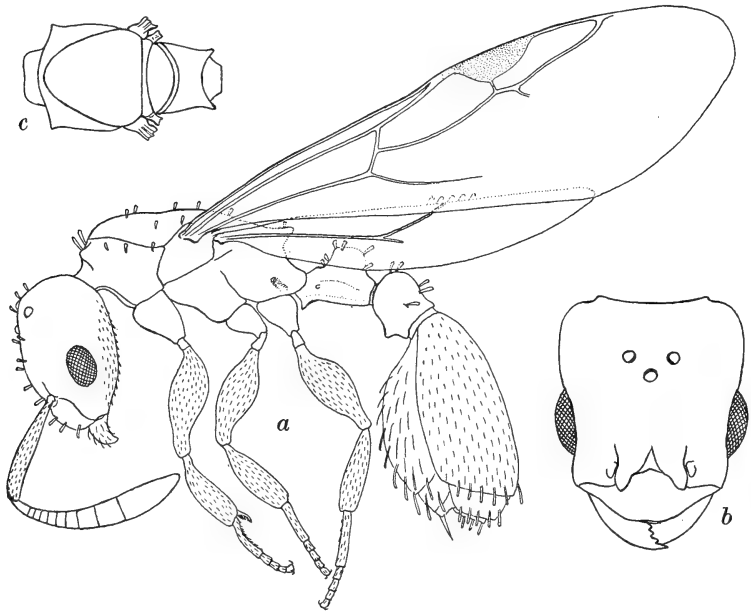


Fig. 1. *Nesomyrmex clavipilis* sp. nov.; a, female in profile; b, head; c, thorax of same seen from above.

Clypeus and front feebly, longitudinally rugose; remainder of head above indistinctly reticulate-rugulose.

Hairs and pubescence yellowish, the former sparse and clavate on the clypeus, upper surface of the head, thorax, pedicel and tip and lower surface of the gaster, longest on the venter and posterior borders of the gastric segments. Pubescence of scapes, cheeks and legs short, on the upper surface of the first gastric segment longer and coarser.

Color yellowish brown; mandibular teeth, eyes and a spot at the inner border of each ocellus, black. Head with a brown impressed spot about the size and shape of the eye on each side between the eye and the lateral ocellus. Wings yellowish gray, with dilute yellow veins and pale brown apterostigma.

Described from a single specimen (No. 13197, U. S. Nat. Mus. Coll.) taken by Mr. H. H. Smith at Balthazar on the windward side of the Island of Grenada, W. I.



The genus *Nesomyrmex*, so far as it is possible to judge from this female specimen, is closely related to *Leptothorax*. It differs, however, in venation, especially in lacking the discal cell, and in the structure of the head and thorax.

***Apsychohyrmex* gen. nov.**

*Worker.* Small species allied to *Rogeria* Emery. Head rather large; mandibles moderately convex, dentate. Clypeus very short, much depressed on the sides, elevated in the middle to form a narrow, bidentate plate, which is fused with the frontal carinæ. These are well developed, rather closely approximated and projecting upward and slightly outward, and include an elongate, impressed frontal area which runs forward as a narrow groove to the tip of the clypeal plate. Antennal fossæ large, continued backward and outward over the sides of the clypeus. Eyes small, consisting of a few ommatidia, placed a little in front of the sides of the head. Ocelli absent. Antennæ stout, 12-jointed, funiculus ending in a 2-jointed club, the last joint of which is very large and glandiform; joints 2-8 transverse, much broader than long. Thorax scarcely longer than the head, including the mandibles, narrower than the head, with rounded humeri and inferior pronotal angles; without promesonotal and mesoepinotal sutures; pro- and mesonotum convex and rounded above; epinotum narrowed and more depressed, dentate; episternal angles short, rather acute. Petiole pedunculate, without an anteroventral tooth; node well-developed. Postpetiole short, very convex above, constricted behind. Gaster larger than the head, oval; first segment large, convex dorsally; sting apparently very small or vestigial. Legs rather stout; femora feebly clavate; middle and hind tibiæ without spurs. Body, excepting the gaster and appendages, coarsely sculptured. Hairs long and simple.

***Apsychohyrmex myops* sp. nov.**

(Fig. 2.)

*Worker.* Length 2.3 mm.

Head distinctly longer than broad, subelliptical, with feebly convex posterior and evenly rounded anterior borders, as broad in front as behind. Mandibles with oblique masticatory borders, bearing 2 stout apical and 2 or 3 smaller basal teeth. Antennal scapes reaching about half way between the eyes and the posterior corners of the head; first funicular joint nearly as long as the two succeeding joints taken together; joints 2-8 subequal; joint 9 somewhat longer; joint 10 twice as long as joint 9; distinctly broader and separated off from it as the base of the 2-jointed club; terminal joint more than  $\frac{2}{3}$  as long as the remainder of the funiculus. Epinotum with subequal base and declivity, the former horizontal, the latter straight and sloping; teeth short, acute, directed upward, outward and backward. Petiole with a high, rounded node, which has a long concave anterior and shorter, more abrupt, convex posterior slope; seen from above the node is about as broad as long. Postpetiole from above circular, a little broader than the petiole, very convex above, with an acute, transverse welt on its very short ventral side.

Mandibles somewhat shining, coarsely and sparsely punctate. Head, thorax, petiole and postpetiole subopaque, coarsely reticulate-rugose, cheeks and pleuræ

indistinctly longitudinally rugose; lower surface of petiole, and posterior declivity of the petiole and postpetiole transversely rugose. Frontal area smooth and shining; epinotal declivity and gaster shining, the former rugulose, the latter very finely and indistinctly punctate. Antennal scapes and legs shining and sparsely punctate.

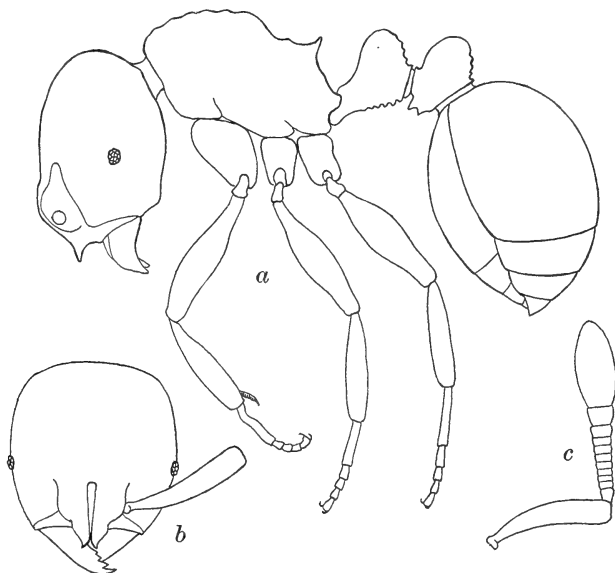


Fig. 2. *Apsychomyrmex myops* sp. nov.; a, worker in profile; b, head of same from above; c, antenna.

Hairs yellowish, very long and flexuous; erect or suberect on the body and mandibles, appressed on the legs and scapes.

Body black, with deep red articulations; mandibles, legs and antennæ ferruginous; scapes and middle portions of the femora and tibiæ blackish.

Described from a single specimen (No. 13198, U. S. Nat. Mus. Coll.) taken by Messrs. Schwarz and Barber at Livingston, Gautemala.

The genus *Apsychomyrmex* is, in many respects, rather closely related to *Rogeria*, especially in general habitus, the shape of the head, thorax and petiole and in having small eyes and 12-jointed antennæ, but it differs in the shape of the clypeus, with the bidentate median plate fused with the frontal carinæ, in the size and prominence of these carinæ, the extent of the antennal fossæ, in having 2-jointed instead of 3-jointed antennal clubs, in the spurless middle and hind tibiæ and the much coarser sculpture. It is probable that the *Myrmica blanda* described by F. Smith from Brazil belongs to *Apsychomyrmex* rather than to *Rogeria*. Smith describes the antennæ of this ant as having 3-jointed clubs, and as will be seen from the accompanying figure (Fig. 2c) the composition of the club in *Apsychomyrmex* may be open to this

interpretation. There is, however, a somewhat more marked constriction between the antepenultimate and penultimate joints than between the former and the remainder of the funiculus in the species here described.

**Lachnomyrmex** gen. nov.

*Worker.* Small and monomorphic. Head nearly as broad as long, broader behind than in front, convex above. Mandibles dentate at the apex. Ocelli absent. Eyes rather small, convex, consisting of large ommatidia, situated in front of the middle of the head and below a deep scrobe, which is confluent anteriorly with the antennal fovea and is large enough to enclose the whole antennal scape. Frontal carinae broad, square in front, projecting laterally on each side over the anterior portion of the scrobe and continued back as its sharp mesial border. Frontal area and groove obsolete. Clypeus narrow, convex, with rounded, projecting anterior border. Antennae 12-jointed; funiculus with a distinct 2-jointed club and joints 2-9 very short. Thorax narrower and somewhat longer than the head including the mandibles, narrower behind than in front; pro- and mesonotum rounded and convex above, not separated by a suture; inferior pronotal angles rounded; meso-epinotal constriction pronounced; epinotum depressed, armed with long spines; metasternal angles prolonged into sharp teeth. Petiole and postpetiole small, with very low nodes; petiole pedunculate, without an anteroventral tooth. Gaster about the size of the head, globose, without anterior angles; first segment very large and convex; sting small and slender. Legs rather stout, femora and tibiae feebly clavate, middle and hind tibiae without spurs. Head, thorax, petiole and postpetiole roughly sculptured. Body and appendages covered with moderately abundant, very long, simple and flexuous hairs.

*Female* (deålated). But little larger than the worker and of a very similar conformation. Eyes and ocelli rather small. Thorax short and stout, but little longer than broad, nearly as high as long and nearly as broad as the head. Mesonotum and scutellum convex; epinotum like that of the worker.

**Lachnomyrmex scrobiculatus** sp. nov.

(Fig. 3.)

*Worker.* Length 2-2.3 mm.

Head with rounded posterior border and corners and nearly straight sides slightly converging anteriorly. Mandibles moderately convex, with two apical teeth and the remainder of the masticatory border sharp and edentate. Clypeus with a few widely separated longitudinal ridges. Antennal scapes slightly incrassated distally, as long as the scrobes; first funicular joint as long as broad; joints 2-9 increasing very gradually in length towards the club but always remaining much broader than long; basal about  $\frac{1}{2}$  as long as the terminal joint of the club. Pro- and mesonotum forming a hemispherical mass, nearly circular when seen from above; epinotum somewhat longer than broad, with subparallel sides; base horizontal, shorter than the concave, very sloping declivity; spines slender, straight and acute, directed upward, backward and slightly outward, longer than their distance apart

at the base and with their extreme tips slightly bent forward. The acute episternal angles are directed upward and their tips are also very feebly recurved in some specimens. Petiole narrow in profile, with a low, rather acute node, with concave anterior and posterior declivities; seen from above the upper border of the node is transverse and the whole segment is but little broader behind than in the region of the peduncle. Postpetiole only  $\frac{1}{2}$  again as broad as the petiole; from above a little broader than long, subrectangular; in profile its upper surface is evenly and feebly rounded, the lower surface short, with a prominent transverse welt anteriorly.

Mandibles smooth and shining, sparsely and inconspicuously punctate. Head, thorax, petiole and postpetiole subopaque, coarsely reticulate-rugose, the rugæ on the upper surface of the head longitudinal, less coarse and much more irregular on the thorax, petiole and postpetiole. Antennal scrobes and epinotal declivity shin-

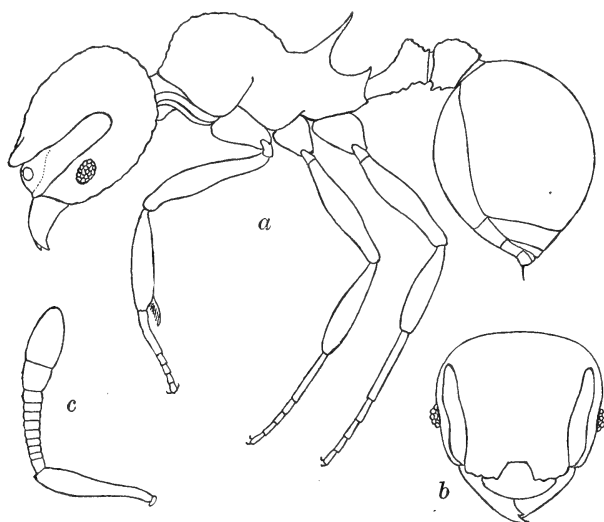


Fig. 3. *Lachnomyrmex scrobiculatus* sp. nov.; a, worker in profile; b, head of same from above; c, antenna.

ing, transversely rugulose. Gaster, legs and scapes glabrous and sparsely punctate.

Hairs white, very long and erect or suberect on the body, more reclinate on the legs and scapes.

Body dark reddish brown; mandibles, antennæ, legs, neck, base of petiolar peduncle and tip of gaster yellowish red; middle portions of femora, tibiæ and scapes brownish.

*Female* (deälated). Length 2.6 mm.

Differing from the worker only in the usual structural characters, in the somewhat shorter epinotal spines, which are slightly curved inward and further apart than in the worker, in the more convex petiolar node and in the sculpture, the pronotum, mesonotum, scutellum and pleuræ being coarsely longitudinally rugose like the upper surface of the head. Color and pilosity the same as in the worker.

Described from a single female and six workers (No. 15199, U. S. Nat.

Mus. Coll.) taken by Messrs. Schwarz and Barber at Cacao, Trece Aguas in Alta Vera Paz, Guatemala. This ant is evidently a timid species, living in small concealed colonies like the species of *Rogeria* and *Leptothorax*.

*Lachnomyrmex* seems to be related to *Apsychomyrmex*, *Calyptomyrmex* and *Agræcomyrmex* gen. nov., to which I refer the peculiar *Myrmica duisburgi* described by Mayr from the Baltic amber. The differences between *Lachnomyrmex* and *Apsychomyrmex* will be readily appreciated by comparison of Figs. 2 and 3. *Calyptomyrmex* and *Agræcomyrmex* both have deep antennal scrobes above the eyes, but the former differs from *Lachnomyrmex* in having 11-jointed antennæ, an unarmed thorax and a very different type of pilosity; while *Agræcomyrmex* does not have a 2-jointed antennal club, the eyes are near the posterior corners of the head and the tip of the gaster is directed forward as in the Ponerine genera *Proceratium*, *Sysphincta*, *Bradoponera*, *Discothyrea* and *Alfaria*.



**Article XXIV.—THE CRETACEOUS OJO ALAMO BEDS OF NEW MEXICO WITH DESCRIPTION OF THE NEW DINOSAUR GENUS *KRITOSAURUS*.**

BY BARNUM BROWN.

PLATES XXVII–XXIX.

A new locality for dinosaurs near Ojo Alamo, in northern New Mexico, was reported to the American Museum by Mr. George H. Pepper, of the Hyde Exploring Expedition in 1902.

The bones submitted at that time were indeterminate but were said to be so numerous that it was thought advisable to investigate the locality. Accordingly, in 1904, the writer was detailed to that region for a preliminary reconnaissance, during which a small but interesting collection of fossils was secured.

This collection is of especial interest, as it represents a fauna that is distinctly older than that of the "Lance Creek Beds or Ceratops Zone" and "Hell Creek beds" of the Laramie Cretaceous. I am unable to definitely correlate the horizon in which these bones occur but the faunal facies appears to be even older than that of Black Buttes, Wyoming, and probably represents a period synchronous with the lower part of the Edmonton series of Alberta, Canada. *The lower Edmonton series has previously been considered equivalent to the Laramie but its fauna, as determined by the writer, is intermediate in age between the Judith River and the Laramie.*

Ojo Alamo is an Indian trading post in Chaco Cañon, about ninety-five miles northwest of Gallup, New Mexico, and twenty miles west of the old Indian pueblo, Bonito, now known as Putnam. It is situated in the eastern edge of the bad land exposures that extend west and south to the Chaco Cañon. On the east and north these bad lands flank a mesa that is dissected on the east by Coal Creek. The escarpments near the head of Coal Creek have furnished a large part of the lower Puerco or basal Eocene fossils of the southwest and may be considered Cope's typical Puerco of 1874. The known fossil-bearing Puerco from which many of Cope's types were obtained, was traced by the writer southwest from Coal Creek and identified with the unfossiliferous bad lands at the head of Ojo Alamo Creek where the strata are weathered into a great amphitheater of open terraces. A careful search through these upper clays failed to reveal either vertebrate or invertebrate

remains, not even fragments. Near their base sandstones predominate and are characterized by quantities of petrified wood with large logs often forming the cap-rock of isolated clay monuments.

Less than a mile south of the store at Ojo Alamo the Puerco formation rests *unconformably* on a conglomerate that is composed of red, gray, yellow, and white pebbles. The position of these beds below what may be called the type of the Puerco or basal Eocene and their unconformable relation is highly significant. The writer is fully aware that the conditions found here, as indicated by the fauna, are not strictly comparable to those of the northern States, where the Fort Union conformably overlies beds now considered Laramie, but it is a point of contact between the uppermost Mesozoic and the lowermost Tertiary and marks the termination of the principal Mesozoic life, the dinosaurs, before the beginning of the Eocene in which no dinosaurs have as yet been found.

Below the conglomerate there is a series of shales and sandstones evenly stratified and usually horizontal, in which there is much less cross-bedding than commonly occurs in the Laramie formation of the northern United States.

The shales below the conglomerate that contain numerous dinosaur and turtle remains I shall designate as the *Ojo Alamo Beds*. They were estimated to be about 200 feet thick, but owing to lack of time I was unable to determine their relation to the underlying formations.

The vertebrate remains were numerous in several places from thirty to one hundred feet below the conglomerate. They consisted chiefly of limb bones, usually lacking the ends, isolated vertebrae and a few skull fragments. Most of this material was chalcedonized, a condition common in the Judith River but never observed in the Laramie. Carnivorous dinosaurs were far more numerous than in the Laramie of the northern United States. The family Trachodontidae is also well represented, but only a few fragments of ceratopsian remains were found.

The ceratopsian fragments were small sections of characteristic squamosal bones, not collected, and part of a supraorbital horn, No. 5798 of the American Museum collection. Both ends of this specimen are broken but very little is gone from the upper end. It is 120 mm. long, 180 mm. in circumference at the base, and 90 mm. in circumference at the upper end; subovate in cross-section and strongly decurved near the upper end, having a greater curve on the convex than on the concave surface. It is much smaller and lacks the vascular grooves that characterize the horns of the genus *Triceratops* and, judging by the form and size, approaches nearest *Monoclonius recurvicornis* of the Judith River formation from which, however, it is distinct. *M. recurvicornis* is proportionately shorter and more



robust. The squamosal fragments of another individual observed in the field were much thinner than that bone in the genus *Triceratops* but similarly marked by deep vascular grooves. The horn and other skull fragments were apparently from a mature animal representing a ceratopsian genus smaller than either *Triceratops* or *Torosaurus*, but the remains are too fragmentary for characterization.

Little can be said of the carnivorous dinosaurs. The remains were numerous; chiefly disassociated limb bones, lacking articular ends but characterized by hollow shafts, and vertebræ representing a dinosaur as large as *A. bertosaurus* of the lower Edmonton series. The single tooth preserved in the collection is not diagnostic.

In the Cope collection obtained from this region, there are several carnivorous dinosaur teeth and a few separate upper teeth of a large Trachodont dinosaur. As these lower Puerco fossils were collected largely from the Coal Creek locality the dinosaur teeth probably came from the Ojo Alamo beds.

Turtle bones were frequently found with those of dinosaurs. They were especially numerous just below the conglomerate. A new species, *Thescelus repiens* Hay, No. 6066, American Museum collection, is founded on the greater part of a carapace closely related to *T. insiliens* Hay, from the Lance Creek beds of Converse County, Wyoming. The genus is nearly related to the Bænidiæ.

The most important fossil from this locality is a skull, lower jaws, and atlas, of a hitherto undescribed genus of the family Trachodontidæ:

### ***Kritosaurus navajovius* gen. et sp. nov.**

Type of species No. 5799, American Museum collection.

*Generic characters.* Skull deep; muzzle narrow; frontals short, orbital portion reduced, barely coming to the border of the orbit; nasals and premaxillaries very long, quadrate elongate; quadrato-jugal short antero-posteriorly, completely separating quadrate and quadrato-jugal. Mandibular rami massive; edentulous portion decurved. Teeth spatulate in lower jaw.

*Specific characters.* Maxillary teeth smooth on borders. Mandibular teeth papillate on borders, median carina low, prementary deep and massive. Free edentulous portion of dentary not covered by prementary, short.

The skull is that of an old individual and most of the sutures are obliterated.

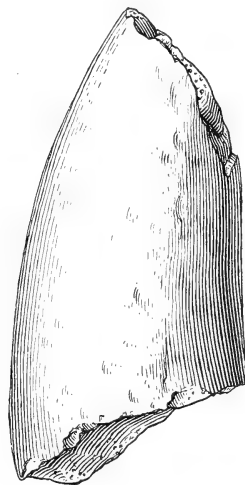


Fig. 1. Ceratopsian horn,  
No. 5798 A. M. N. H.  $\times \frac{1}{2}$ .

ated by exfoliation. When found it was almost completely weathered out and the anterior end was in a very fragmentary condition. It was impossible to place many of these fragments in the restoration and where there was no contact the bones were left out. The dentary and prementary were perfectly preserved, thus determining the length of the skull. The nasals were restored after the skull of *Trachodon* (*Diclonius*) Cope and the premaxillaries according to the relative size between the prementary and premaxillary in that species which necessarily made the rostrum much deeper.

#### SKULL.

The skull is very deep and more massive than in any heretofore described species of the family and its elements in general follow the *Trachodon* form, but with the following distinct modifications.

Premaxillaries and rostrum proportionately shorter than in *Trachodon* (*Diclonius*) *mirabilis* or *Claosaurus annectens* Marsh. Frontal short antero-posteriorly, prefrontal and postfrontal almost excluding it from the border of the orbit. Paroccipital process of exoccipital actually and relatively longer than in *Trachodon*. Orbital opening proportionately smaller and laterotemporal fenestra proportionately larger than in *Trachodon*. Quadrate and jugal completely separated by quadrato-jugal, the exposed part of which is short antero-posteriorly and vertically high. Ectopterygoid extending forward to the union of the maxillary and the jugal.

#### LOWER JAW.

The lower jaw in form resembles more closely Judith River than Laramie species. Its edentulous portion not covered by prementary is shorter than in any Laramie form.

*Prementary.* The two prementaries are firmly coössified forming a single element but clearly show their union in the median line. Its lateral borders are massive and nearly vertical, forming a powerful clipping instrument, whereas in all Laramie forms they are delicate and conform to the shape of the rostral bones. The anterior upper border is very rugose and is perforated by two parallel series of vascular foramina, resembling alveoli but which pass obliquely downward and open on the outer surface. Each arm of the  $\Omega$  terminates in a short rounded inner and a longer outer process. On the posterior lower border in the center there are two processes, an inner short, free, tongue-like process which separates the upper anterior ends of the dentaries and a longer, wider process which underlies the symphysis. The latter process is broken near its origin and shows no indication of bifurcation.



Fig. 2.



Fig. 3.

Fig. 2. Left quadrato-jugal of *Kritosaurus navajovius*.  $\times \frac{1}{2}$ .  
 Fig. 3. Left quadrate of *Kritosaurus navajovius*, type. Rear view.  $\times \frac{1}{2}$ .

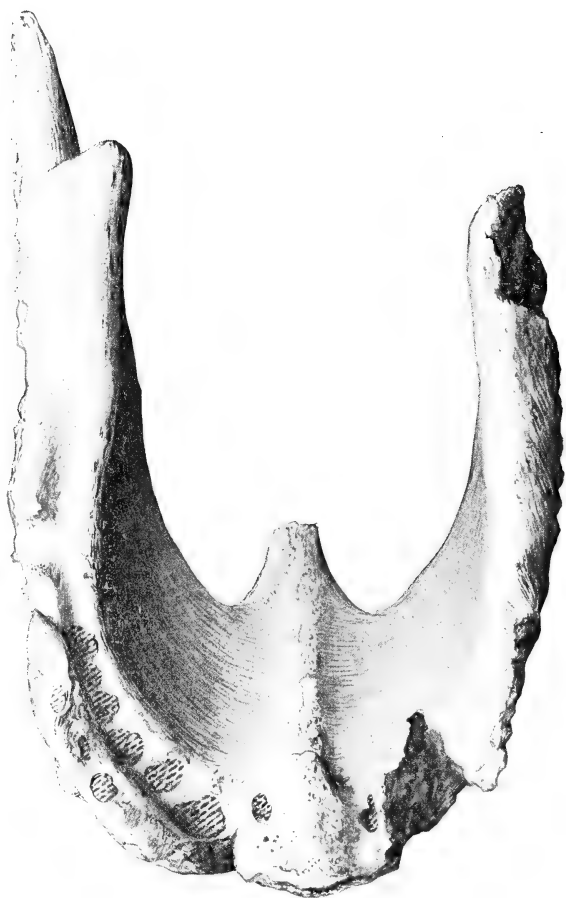


Fig. 4.

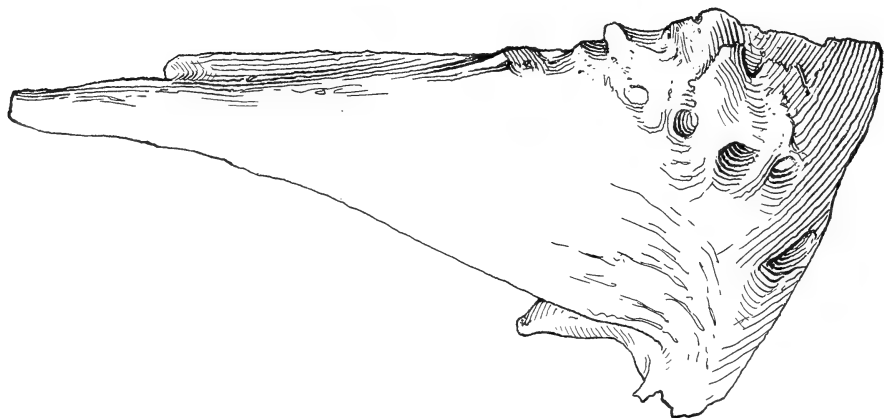


Fig. 5.

Fig. 4. Predentary of *Kritosaurus navajvius*, type. Top view. About  $\frac{1}{2}$  nat. size.  
 Fig. 5. Predentary of *Kritosaurus navajvius*, type. Side view. About  $\frac{1}{2}$  nat. size.



Cretaceous, near Ojo Alamo, New Mexico.

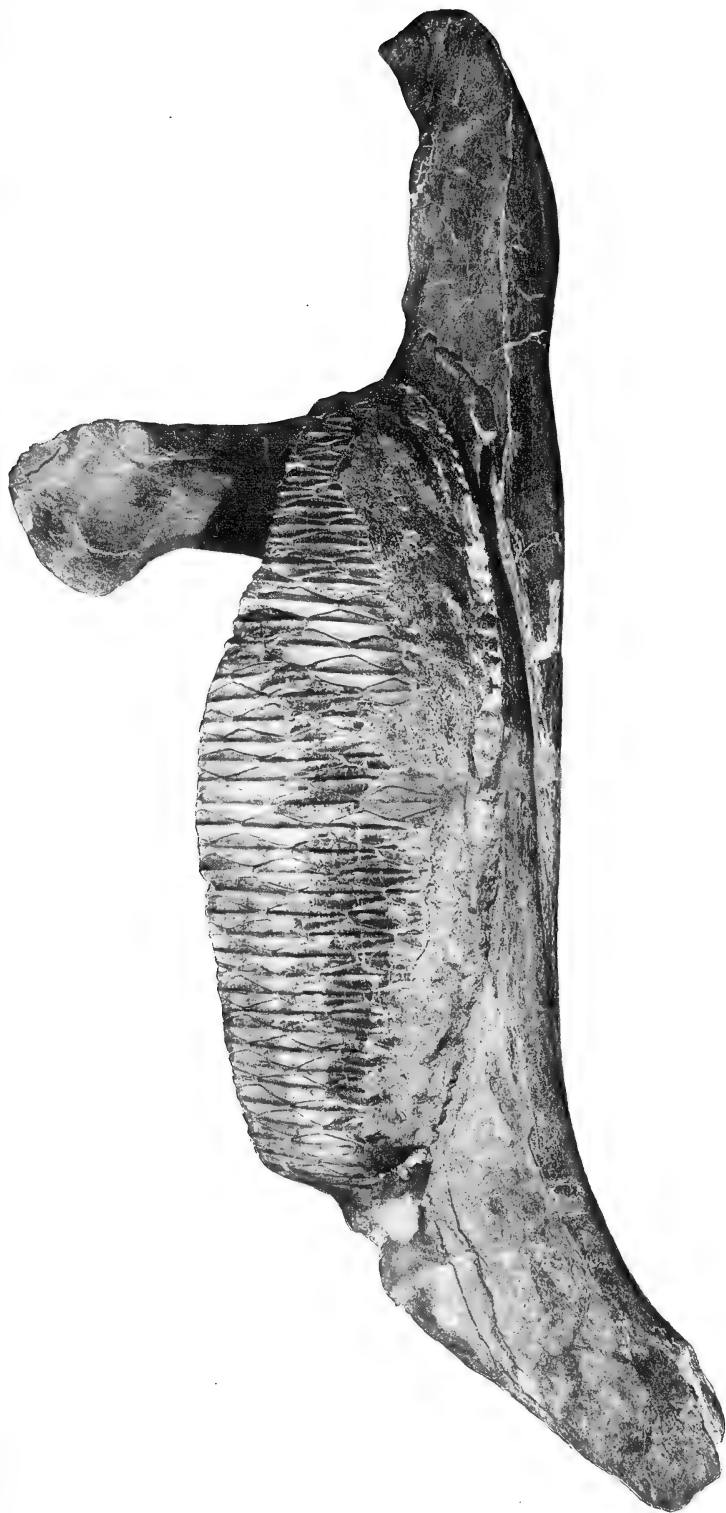




Type skull of *Krilosaurus navajovius*. About  $\frac{1}{4}$  nat. size.







Inner view of lower jaw of *Kritosaurus navajovius*. About  $\frac{1}{4}$  nat. size.



*Dentary.* This element is very massive. The edentulous portion is about one fourth of its entire length, is strongly decurved and near the symphysis curves inward. The coronoid process rises opposite the last row

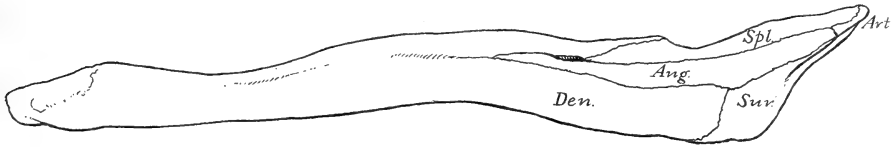


Fig. 6. Inferior view of lower jaw of *Kriticosaurus navajovius*.

of teeth as in the genus *Trachodon*, but the backward prolongation of the surangular gives it the appearance of being further forward. It is intermediate in position, in relation to the complete mandible, between *Trachodon* and the European genus *Hecatasaurus*.<sup>1</sup>

*Surangular.* The surangular is proportionately longer than in *Trachodon*. Its anterior vertical process is truncated obliquely and expanded to continue the posterior lower border of the coronoid process. Posteriorly it broadens and furnishes four fifths of the articular surface for the quadrate.

*Articular.* The articular forms the extreme end of the jaw and is wedged in between the posterior ends of the surangular, angular and splenial. It furnishes about one fifth of the articular surface for the quadrate, in front of which it contracts to a thin wedge but does not reach forward to the end of the dentary process.

*Splenial.* The splenial follows the usual *Trachodon* form.

*Angular.* The angular is very long and narrow. Posteriorly its lower border is visible on the outside of the jaw. Anteriorly it forms the lower border of the Meckelian groove and extends nearly to the middle of the dentary.

#### TEETH.

Two distinct types of teeth appear in the family Trachodontidæ. In the earliest representatives known, *Claosaurus agilis* Marsh from the Niobrara, and species from the Judith River beds that have been referred to *Trachodon*, the enamel face of mandibular teeth is spatulate in form and papillate on the borders. In the later Laramie Cretaceous species the enamel face of mandibular teeth is diamond-shaped with smooth borders.

<sup>1</sup>To replace *Limnosaurus* Nopcsa, 1900; preoccupied by *Limnosaurus ziphodon* Marsh, 1871, Proc. Acad. Nat. Sci. Phila., Vol. XXIII, p. 104.

Type, *Limnosaurus transsylvanicus* Nopcsa, Denk. Ak. Wien, Vol. LXVIII, 1900, pp. 555-591.

The teeth of *K. navajovius* are of the primitive form. Both upper and lower series respectively are larger than in any described species of the family.



Fig. 7. Lingual surface of a lower tooth of *Kritosaurus navajovius*, type.  $\times \frac{1}{2}$ .

In the mandibular series there are 42 vertical rows of teeth. On the triturating surface one tooth, enamel bearing, a half worn tooth, and an indefinite number of worn roots appear in each row. The enamel face of each tooth is spatulate and rather sharply pointed at the summit; median carina low; lateral surface flat; borders not raised above the flat surface and sparsely studded with enamel papillae that apparently lack definite arrangement.

In the maxillary series there are 47 vertical rows, and never more than two enamel bearing teeth appear on the triturating surface in each row. They are smooth on the borders, and strongly curved transversely; median carina very high.

#### Measurements.

##### SKULL.

	mm.
Length, as restored . . . . .	995
Width across frontal above orbits . . . . .	220
Width across proximal ends of quadrate . . . . .	250
Width across distal ends of quadrate . . . . .	490
Frontal, length antero-posteriorly . . . . .	198
Parietal, length . . . . .	113
Supratemporal vacuity, length . . . . .	140
Supratemporal vacuity, width . . . . .	100
Quadrate, height . . . . .	516
Quadrato-jugal, exposed, length anteroposteriorly . . . . .	42
Quadrato-jugal, exposed, height . . . . .	160
Ectopterygoid, length . . . . .	180

##### LOWER JAW

Length without predentary . . . . .	775
Predentary, length . . . . .	240
Angular, length . . . . .	250
Splénial, length . . . . .	260
Articular, length . . . . .	95

##### TEETH

Dental series, upper jaw, length . . . . .	410
Tooth, mid-section lower jaw, length . . . . .	45
Tooth, mid-section lower jaw, width . . . . .	15

Article XXV.—FOSSIL INSECTS AND A CRUSTACEAN FROM  
FLORISSANT, COLORADO.

By T. D. A. COCKERELL.

TRICHOPTERA.

*Derobrochus typharum* sp. nov.

Length 13 mm.; anterior wing  $12\frac{1}{2}$ , posterior nearly 11; breadth of anterior wing  $3\frac{1}{2}$  mm.; ferruginous, wings clear or nearly so, minutely and sparsely hairy, with ferruginous veins; thorax with a moderate number of stout black bristles, about  $595\ \mu$  long; antennæ rather thick, diameter near middle about  $235\ \mu$ , with transverse rows of minute hairs, about  $40\ \mu$  long; middle (?) tibia with two apical spurs. This agrees with Scudder's definition of *Derobrochus*, in that it is a Hydropsychid, with apical forks one to four present, and the fifth absent. It is well preserved, and I think there is no doubt whatever that the cubitus is simple in both upper and lower wings. (Scudder says that the fifth apical cell, *i. e.* the third fork, is absent, but his figures contradict this, and it is evident that the fifth fork is intended.) The new species is larger than any of Scudder's *Derobrochus* forms (some of which are very dubious, see Bull. Am. Mus. Nat. Hist., XXIII, p. 610), and differs in the details of the venation. In spite of the excellent preservation, I cannot see any cross-veins, nor are the longitudinal ones deflected at the points where they might be expected; it really seems, therefore, that the discoidal and median cells were open apically.<sup>1</sup>

*Anterior wing.* Subcosta and radius as in *Hydropsyche*, the latter a little deflected downwards at the beginning of the scarcely darkened pterostigma; both forks of radial sector very long, especially the lower, measured on the lower nervure, the first fork is about  $3485\ \mu$ , the second  $5950$ ; forks of the media (third and fourth forks) also long, base of third a short distance basad of level of base of first, base of fourth a slightly greater distance basad of level of base of second; cubitus very straight.

*Posterior wing.* Venation as in anterior wing, with the same forks etc.

*Hab.* — Miocene shales of Florissant, Station 14 (*Geo. N. Rohwer*).

On the reverse side of the slab is a specimen of *Typha lesquereuxi* Ckll. The second fork is not nearly twice as long as third, and the first fork is much shorter than second; from these and other characters the insect comes nearest to *D. crateræ* in Scudder's table, but the anterior wings of *D. crateræ* are only 8 mm. long. The size of the first fork at once separates *D. typharum* from Scudder's *Litobrochus*.

<sup>1</sup> There is the faintest suggestion of a deflection on upper side of second fork, just basad of level of base of first; this may perhaps indicate the place of a former cross-vein.

**Indusia cypridis** sp. nov.

Larval case cylindrical, perfectly straight, about 11 mm. long (end broken) and  $2\frac{1}{2}$  broad, composed of *Cypris florissantensis* shells and small fragments of biotite.

*Hab.*—Miocene shales of Florissant, 1909 (George Sternberg).<sup>1</sup> Am. Mus. Nat. Hist., No. 10190.



Fig. 1. *Indusia cypridis* sp. nov., with *Cypris florissantensis* sp. nov.

This is of interest, because Scudder wrote (Tertiary Insects, p. 178) as follows: "That in the abundant fauna found in the lake basin of Florissant, including, as we see, a large number of caddis-flies, not a single larval case should have yet been found seems a little remarkable, and the more so since not a few belong to groups, the larvæ of which are known to prefer standing to running water."

**Hydropsyche scudderi** Ckll.

Florissant, 1909 (Geo. Sternberg). Am. Mus. Nat. Hist.

## EPHEMEROIDEA.

**Ephemera howarthi** Ckll.

Florissant, 1909 (Geo. Sternberg). Am. Mus. Nat. Hist.

## ODONATA.

**Æshna larvata** Scudder.

Florissant, 1909 (Geo. Sternberg). Am. Mus. Nat. Hist.

## HYMENOPTERA.

**Eriocampa pristina** sp. nov.

Length about 10 mm.; anterior wing about  $7\frac{1}{2}$ ; wings clear hyaline; head and thorax black, abdomen light ferruginous; venation normal, except that I cannot see any discal cells in the hind wings, and although the part is not very well preserved, the outer bounding nervures, if present, must have been very slight. In Rohwer's table of fossil *Eriocampa* (Bull. Am. Mus. N. H., 1908, p. 592) this runs out, because

<sup>1</sup> The Sternberg collection was obtained in 1909 by George Sternberg, with the assistance of Terry Duce and Willard Rusk.

the second cubital or radial is much longer than first on cubitus, and yet not nearly twice as long, and in addition the clear wings separate it from *E. scudderi*, and the larger size from *E. bruesi*. In the following account of the wing, all measurements are in microns: Costal cell large (as in *Eriocampa*, not as in *Pseudosiobla*), and apparently with a cross nervure; stigma large; first transversocubital produced to costa would make a large angle (as in *Eriocampa*, not as in *Eriocampoides*); sides of first discoidal cell approximately parallel (as in Emphytinæ, not as in Phyllotominæ); third transversocubital strongly arched inwards; lower apical corner of third discoidal cell a little less than a right angle; lanceolate cell with an oblique cross nervure and strong subbasal contraction, as is normal for the genus.

End of stigma to end of marginal cell, 1955; end of third submarginal to end of marginal 1120; end of cross nervure on marginal to upper end of third transversocubital 305; end of cross-nervure on marginal to upper end of second transversocubital 715; second submarginal on marginal 885; first submarginal on first discoidal 476; second submarginal on first discoidal 305; third submarginal on third discoidal about 290; basal nervure on first discoidal 1190; first discoidal on third 680; lower end of basal nervure to upper end of transversomedial 510; second discoidal on first 645; length of transversomedial 545; transversomedial to upper end of cross-nervure of lanceolate cell 985.

*Hind wing.* End of lanceolate cell to lower apical corner of median 325; length of apical side of median 340; median on lower discal (this cell however apparently incomplete on outer side) 580; subcostal on lower discal 680. Compared with Macgillivray's figure of *E. ovata* (Proc. U. S. Nat. Mus., XXIX, pl. XXVIII) not only do the outer nervures bounding the discal cells seem to be absent, or are at least very weak, and obliterated in the fossil (as in *Emphytus*), but there are other differences in detail. In *E. ovata* the lower discal on the subcostal is about twice as long as on the median cell; in *E. pristina* it is only about a sixth longer.

*Hab.*—Miocene shales of Florissant 1909 (*George Sternberg*). Amer. Mus. Nat. Hist., No. 10314.

### ***Geotiphia sternbergi* sp. nov.**

♀ (apparently); length  $17\frac{1}{2}$  mm., anterior wing about  $11\frac{1}{2}$ , width of head about  $3\frac{1}{4}$ , of thorax 4, of abdomen about middle 5, length of abdomen  $10\frac{3}{4}$  mm.; flagellum thick, tapering, formed exactly as in female *Plesia*; inner orbital margins gently concave; front roughened or punctured, but thorax apparently smooth or nearly; the head and thorax black; posterior margin of prothorax straight or nearly, mesothorax short, as in related genera, but longer than prothorax in middle line; parapsidal grooves distinct; abdomen large, broadly sessile, black, apparently ferruginous at extreme sides, shaped as in the Scoliids; legs black or nearly; hind femora very stout, apparently much as in *Plesia*; hind tibiae about  $2\frac{3}{4}$  mm. long, thick, probably spinose or dentate on outer side, but this part is not clearly preserved; hind spur well developed; hind tarsus about 4 mm. long, the joints produced apically as in *Plesia*; wings strongly reddish, the stigma dark fuscous, nervures ferruginous. The venation agrees in general with that of *G. foxiana*, the type of the genus, but the third submarginal cell is very large, and its apex is level with the tip of the marginal; the first discoidal is very long and narrow. In the following description all measurements are in microns: costal cell well developed, fuliginous; stigma well developed but elongate, yet little intruding in marginal cell; marginal cell ending very obtusely, the apex practically narrowly truncate, the upper end of

the truncation closely adjacent to costa; length of marginal cell about 3145, its depth 970; upper end of basal nervure about 1360 from stigma; basal nervure meeting transverso-medial; lower section of basal straight, 595 long; length of first submarginal cell 2550; of second submarginal, 1190 above and 2210 below; first recurrent nervure reaching second submarginal cell 850 from base, second reaching third submarginal (at right angles) 375 from base; first transverse-cubital nervure very oblique, strongly bent just before its lower end; outer side of third submarginal greatly bulging, rounded; diameter or length of third submarginal on marginal 1360, below 1190, but in middle about 1700; first discoidal cell 3060 long and 765 greatest depth.

*Hab.*—Miocene shales of Florissant, 1909 (George Sternberg). Am. Mus. Nat. Hist., No. 10235.

This fine species is very distinct from *G. foxiana* (Bull. Mus. Comp. Zool., Vol. L, No. 2, 1906, p. 51) by its large size and some of the details of the venation, but I think it is unquestionably congeneric.

Mr. Rowland E. Turner, who has paid great attention to the living relatives of these insects, has very kindly sent me the following discussion of *Geotiphia*: "*Geotiphia* seems to be very near some of the South American species of *Anthobosca*, especially *iheringii* Sauss., the female of *antennata* Sm. I think it should certainly be placed in Ashmead's family Cosilidæ rather than in his Tiphidæ. You may have seen Fox's remarks on the differences in the unguis and legs of *Cosila* in his description of *C. donaldsoni*, and eventually I think it may be necessary to restrict the name *Anthobosca* to the Australian species, but where the sexes differ so widely I am not in favor of splitting until more species are paired. Probably *Lithotiphia* also belongs to the Cosilidæ, but seems to be more distinct. I quite agree with you in regarding these as primitive forms as compared with the modern Scoliidæ and Thynnidæ, both of which are probably derived from ancestors more nearly resembling *Cosila*, which have died out in the northern hemisphere without developing in the direction of the Thynnidæ, the one or two species of that family described by Ashmead from S. California being probably stragglers from the S. American fauna. The remarks in your paper on the spines of the hind tibiæ are useful; I have been recently studying this character in the Thynnidæ, and hope to be able to make some use of it in generic division. I have not as a rule found differences in the neurulation such as you give in your table of much value in the Scoliidæ. The proportionate length of the marginal and third submarginal cell differs very much in the males of *Tiphia* and in the females of *Anthobosca*, and I do not think it can be used as more than a specific character. If your genus *Geotiphia* stands it will I think have to include most of the S. American *Anthobosca*, from which *Cosila chilensis* Guér. may be separable. The neurulation in the latter species is rather peculiar, the second cubital cell receiving both recurrent nervures in the male specimens I have seen, but



only one in the females. The ventral constriction between the first two abdominal segments is absent in many of the Thynnidae, especially in the females." (Litt. Aug. 3, 1908.)

### ***Geotiphia halictina* sp. nov.**

Length about 8 mm., anterior wing about  $4\frac{1}{2}$ ; head and thorax black, abdomen ferruginous, the latter extending about 2 mm. beyond the wings; robust form and sessile abdomen as in *G. sternbergi*; from its small size and rather robust form it looks exactly like a bee, *Halictus* or some near relative; wings reddish-hyaline, nervures ferruginous; legs ferruginous; thorax not evidently punctured or otherwise sculptured.

The venation is practically as in *G. sternbergi*, but the very obtuse end of the marginal cell extends a little beyond the third submarginal, and the second recurrent nervure joins the third submarginal cell (at right angles) a little beyond the middle. The following measurements are in microns: length of marginal cell 1225; sub-stigmatal part of marginal about 255; upper apical corner of third submarginal to apex of marginal 305; second submarginal on marginal 325; length (or diameter) of third submarginal in middle about 630.

The venation of the hind wing is well preserved, and agrees in the main with *Plesia*, differing however as follows:—

- (1.) The transversocubital nervure, instead of being vertical, is oblique, the lower end more basad.
- (2.) The lower end of the cubitobasal nervure, instead of failing to reach the transversomedial, goes about  $150\ \mu$  basad of it, and the transversomedial is more oblique.

*Hab.*— Miocene shales of Florissant (*Univ. of Colo. Exped.*). On the same slab, close to the insect, is a leaf of *Populus lesquereuxi* Ckll.

### ***Selandria sapindi* n. sp.**

Length about 8 mm.; anterior wing about 7; abdomen about 5, oblong; the head and thorax were apparently dark, the abdomen pale, with a broad dark band near the apex, and indications of narrow bands or marks at the sides of the first two segments; wings clear, nervures dark ferruginous. The venation of the anterior wings is well preserved, and from the form of the lanceolate cell, and other characters, indicates a member of the Selandriinae as restricted by Macgillivray. The rather short and broad abdomen, and the much thickened costa, bulging before the stigma, indicate the genus *Selandria*. The character of the venation may be understood by comparison with Macgillivray's figures of *Stromboceros* and *Strongylogaster* in Proc. U. S. Nat. Mus., XXIX, pl. xxix, figs. 50 and 51.

Costal region much thickened, the costal cell a mere streak; stigma very thick, obtuse at apex, deeper in proportion to its length than in either of Macgillivray's figures; marginal cell ordinary, tapering, the cross nervure very oblique and rather arched, as in *Strongylogaster*; first s. m. shaped as in figure of *Strongylogaster*, the cubital nervure also strongly bent downwards near origin; t. m. more remote from b. n. than in either of Macgillivray's figures.

The hind wings are partly visible, and all that can be seen is quite normal. The discoidal cell has a subvertical base, as in the figure of *Stromboceros*, not as in *Strongylogaster*.

The following measurements of the anterior wing are in microns:

End of stigma to end of marginal cell . . . . .	2210.
Upper end of second t. c. to lower end of cross-nervure of marginal cell . .	630.
Lower end of cross-nervure of marginal cell to upper end of third t. c. . .	390.
Second s. m. on first discoidal . . . . .	410.
Second s. m. on third discoidal . . . . .	680.
Third s. m. on third discoidal . . . . .	340.
First discoidal on submedian cell . . . . .	900.
First discoidal on second discoidal . . . . .	425.

*Hab.*— Miocene shales of Florissant, Station 14, in red shale (*Geo. N. Rohwer*).

The insect is almost touching a leaflet of *Sapindus*. Close to the leaflet is a small shell, *Planorbis florissantensis* Ckll.

This is the first *Selandriina* from Florissant. An undescribed *Selandria* is said to occur in Baltic Amber.

## ORTHOPTERA.

### *Capnobotes silens* (Scudder).

A single tegmen overlaps the reverse of the type leaf of *Sambucus newtoni* Ckll. It is  $33\frac{1}{2}$  mm. long as preserved, but the base is lacking, and the total length would no doubt be 35 to 38 mm.; the width near middle is about 7 mm.; pale, without markings, but anal margin infuscated. The venation is like that of the recent *C. fuliginosus*, but the costal field is narrower apically (its width only about one mm., some 15 mm. from apex); in the basal field the media is closer to the radial sector. The radial sector separates from radius  $27\frac{3}{4}$  mm. from apex of tegmen.

*Hab.*— Miocene shales of Florissant (*Geo. N. Rohwer*). Scudder's type (*Locusta silens*) was a little larger. Scudder's figure gives no idea of the venation.

## DIPTERA.

### PTYCHOPTERIDÆ.

### *Bittacomorpha miocenica* sp. nov.

♂. Length about 8 mm.; wing  $6\frac{1}{4}$ ; hind legs about 16; thorax elevated; abdomen strongly clavate; as preserved the whole insect is ferruginous, and there is no evidence that the legs were bicolored; wings without evident markings (a doubtful cloud at end of basal cells and a little beyond), veins ferruginous; venation perfectly typical for *Bittacomorpha*, but second submarginal cell about as long as its stem (much shorter in *B. clavipes*), and wing not so long and narrow as that of *B. clavipes* (though longer in proportion to body). Length of second submarginal cell

about 1785  $\mu$ , of its stem about 1615; lower side of posterior cell only moderately bent; end of basal cells midway between base and apex of wing.

*Hab.*— Miocene shales of Florissant, Station 13 B (*Geo. N. Rohwer*).

Among the recent species, this seems to be nearest to *B. sackenii*. Although it is unquestionably a *Bit-tacomorpha*, it is somewhat less specialized than the living forms, as shown by the more normal proportions of wings and body, and longer second submarginal cell. Needham (Bull. 124, New York

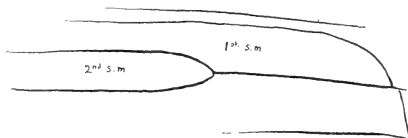


Fig. 2. *Bittacomorpha miocenica* sp. nov.

State Museum, p. 244) and Handlirsch (Ann. k. k. Nat. Hofmuseums, Wien, 1909, p. 269) agree in recognizing the Ptychopteridae as a distinct family. It is divided into subfamilies and genera as follows:

- (1.) Etoptychopterinae.  
*Etoptychoptera* Handl. One species. "Oligocene" of British Columbia.
- (2.) Ptychopterinae.  
*Ptychopterula* Handl. One species. Upper Oligocene of Bohemia.  
*Ptychoptera* Meigen. Eight living species, five European, three North American.  
*Bittacomorpha* Westw. Four living species in North America; one in the Miocene of Colorado.
- (3.) Macrochilinae.  
*Macrochile* Lw. One species. Oligocene (amber) of Europe.
- (4.) Tanyderinae.  
*Protanyderus* Handl. *P. vipio* (O. S.). Living in California.  
*Protoplasa* O. S. *P. fitchii* O. S. Living in E. United States.  
*Tanyderus* Phil. *T. pictus* Phil. Living in Chile.  
*Radinoderus* Handl. *R. ornatissimus* (Dolesch.). Living in Amboina.  
*Mischoderus* Handl. *M. forcipatus* (O. S.). Living in New Zealand.

Thus the group appears to be an old one, represented to-day by scattered fragments.

#### TIPULIDÆ.

##### ***Tipula needhami* sp. nov.**

♀. Length 20 mm. or a little over; wing 18 mm. long,  $4\frac{1}{2}$  deep; eyes 425  $\mu$  apart; wings uniformly grey, not shaded along the veins, with the usual slight brownish stigmal spot; abdomen pale reddish, with a median stripe and broad oblique lateral marks; middle femur 11 mm., its tibia slightly over 11; hind femur  $12\frac{3}{4}$  mm., its tibia  $13\frac{3}{4}$ , its tarsus over 17 (end missing); the following wing-measurements are in microns; length of discal cell about 1990, its greatest depth 900; stalk of second posterior cell 510; length of first marginal cell 3800; first marginal on first basal 2890; combined depth of basals near end 2370.

*Hab.*— Miocene shales of Florissant (*Geo. N. Rohwer*).

Dedicated to Professor J. A. Needham, in recognition of his important contributions to the knowledge of the Tipulidæ. In Scudder's table (Proc. Amer. Phil. Soc., XXXII, p. 63) this runs nearest to *T. evanitura*, but is larger, with longer legs, and appears to be distinct. The first marginal cell is unusually long. *Tipula* was remarkably abundant at Florissant, and while some of the described species are possibly of doubtful validity, the present list (16 species) will not be much if at all reduced.

Scudder remarks on the large proportion of extinct genera among the Florissant Tipulidæ. It is to be noted, however, that except for the evolution of distinct species, the genera common to the Florissant Miocene and the present American fauna have shown no appreciable advance. Thus the fauna has changed by the extinction of certain genera and the arrival of others from elsewhere.

It would be interesting to compare the existing Tipulid fauna of Florissant with the fossils, but unfortunately it is scarcely known. The following species were collected by Mr. S. A. Rohwer at Florissant, and determined by Mr. Coquillett: *Helobia hybrida* Meig.; *Erioptera caliptera* Say; *Tricyphona vitripennis* Doane; *Ptychoptera* sp. I have taken *Molophilus comatus* Doane on Pike's Peak, which is not far from Florissant.

***Tipula heilprini* Scudder.**

The American Museum contains specimens collected at Florissant by George Sternberg.

***Tipula rigens* Scudder.**

North end of Fossil Stump Hill, Florissant, layer 16 (*W. P. Cockerell*).

***Tipula clauda* Scudder.**

Florissant, 1909 (*Geo. Sternberg*). Amer. Mus. N. Hist.

ASILIDÆ.

***Taracticus contusus* sp. nov.**

Length about 9 mm., black, the abdominal segments with the posterior half or somewhat less pallid ventrally; legs rather robust; wings clear, veins dark. The venation is practically normal for *Taracticus*; compared with *T. octopunctatus* (Trans. Am. Ent. Soc., XXXV, pl. xi, p. 3) it differs only by the narrower second submarginal cell, which flares only a little at its apex, and is there not quite so broad as the end of the first posterior; also, the fourth posterior seems to be more contracted, but its lower part, along with the anal, is missing. The discoidal on second posterior is rather greater, instead of less, than on third posterior, a feature which agrees sufficiently with *Taracticus*, but disagrees with *Heteropogon* and *Pycnopogon*. The

anterior cross-vein is  $765\ \mu$  from base of discal cell, and  $560$  from its apex; in being beyond the middle of discal cell it agrees with a little group of genera including *Taractacus*, *Heteropogon*, *Saropogon*, &c, but disagrees with many others. The first submarginal cell goes more basad than the discoidal, which is another good character, excluding various genera. From the end of the auxiliary vein to the end of the first vein is  $1530\ \mu$ ; from the end of the first to the level of the apex of the wing is  $1275$ .

*Hab.*—Station 14, Miocene shales of Florissant.

The genus *Taracticus* to-day inhabits the eastern United States. I have a note of the occurrence of an undetermined species in New Mexico, however.

While on the Dasypogonine Asilidæ, I will add a couple of records of Rocky Mountain species to those given by Back in his revision.

*Stenopogon breviusculus* Lw. Las Vegas, New Mexico, June 19 (*Martin D. Cockerell*). Back only gives California.

*Deromyia angustipennis* Lw. Common at Boulder, Colorado, preying on *Apis mellifera ligustica* (Spin.) and *Polistes variatus* Cress. I noted that when attacking *Polistes* it held it "at legs length", so that it could not sting, and at an opportune moment thrust its beak into the wasp's thorax.

#### NEMESTRINIDÆ.

#### **Hirmoneurites** gen. nov.

Large robust flies with short proboscis; eyes bare; sides of abdomen tufted with hair; venation in most respects like that of *Hirmoneura*, but with the first basal cell rather broadly truncate at end, and the second posterior divided into two by a vertical cross-nervure; three submarginal cells, the third broadly truncate at base.

#### **Hirmoneurites willistoni** sp. nov.

Length about 20 mm.; very robust; width of head 5 mm., of thorax 7, of abdomen near base  $7\frac{1}{2}$ ; abdomen beyond middle rapidly tapering to a pointed apex; head and thorax black, abdomen dark red-dish, sides of abdominal segments with abundant black hair; wings about 14 mm. long, hyaline with dark veins; no sign of any long proboscis (a slight superficial appearance of one is caused by a small gnat, which is placed so as to touch the side of the head); eyes large, about  $1\frac{1}{2}$  mm. apart on front, naked, the facets about the same size as in *Hirmoneura occultator*; legs ordinary, not hairy, width of hind femora near end about  $715\ \mu$ .

Subcosta (mediastinal vein) and radius (first vein) normal, ending a little over 1 mm. apart, and the radius about 2 mm. from apex of wing; radial sector (second

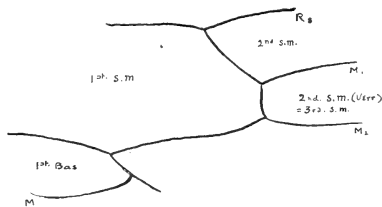


Fig. 3. *Hirmoneurites willistoni* sp. nov.

vein) as in *Hirmoneura*, a little curved upwards at end, its middle section about 3 mm., and apical a trifle more; outer radiomedial cross-nervure (separating first and second submarginal cells) present, as in American *Hirmoneura* (but not in *H. obscura*, the type of the genus), not very oblique (not very different from that of *Hirmoneura vulcanica*); cell between apical forks of media (third submarginal) broadly truncate at base, as in *H. vulcanica*, the cell broader near base than beyond, herein shaped as in *H. melanderi*; media dislocated at diagonal vein, the basad portion about 220  $\mu$  below the apical (in other genera it is either not dislocated, or is above, but is a trifle below in *H. obscura*), hence the first basal cell is truncate at end and the discal cross-vein is well defined: upper branch of cubitus not dislocated by diagonal vein, but lower branch dislocated about 135  $\mu$ , the basad section the lower (practically as in *H. obscura*); diagonal vein continued to margin, which is indented at its end; cubital branches beyond diagonal vein (bounding second posterior cell) ending separately on margin (about 340  $\mu$  apart), but about 1½ mm. from diagonal vein joined by a vertical transverse cross-vein, the upper branch being drawn into a wide V at the cross-vein; this encloses an extra cell, making two between the cubital branches (evidently normal, being quite the same on both sides); the branching of the cubitus is not very distinctly preserved, but the stem is continuous with the upper branch, and the lower is bent downwards, perhaps much as in *Fallenia fasciata*.

*Hab.*—Miocene shales of Florissant, 1909 (*George Sternberg*). Am. Mus. Nat. Hist., No. 10244.

I have used the nomenclature of the venation of my earlier papers on Nemestrinidæ (*cf.* Trans. Amer. Ent. Soc., XXXIV, plate xvi), which is based on the supposition that the venation of this family is much more primitive than has generally been supposed. This is supported by the occurrence of a Nemestrinid in the Jurassic rocks of Bavaria. Some time ago I sought Dr. S. W. Williston's opinion on this matter, and while he was not in a position to take it up in detail, his comments are so illuminating that I take the liberty of quoting them. They were written from the field in Texas, twenty miles from the nearest post office, and of course without books or specimens at hand.

"I at once saw that if your Nemestrinid veins were correct they must apply to *all* Diptera, and that the subject is impossible of proof pro or con, for the reason (among others) that the anterior cross-vein and the vein you would call the cross-vein are *never* absent in Diptera when there is a functional venation. When I grasped the *general* applicability of the theory, it struck me as not unreasonable,—but unprovable! There is this much against it,—the second vein sometimes arises from beyond the cross-vein (*Stratiomyidæ*, etc.) that is, the cross-vein connects the second with the fourth. The third and fourth veins may be coalescent (that is, the cross-vein obsolete) in the *Tipulidæ*, *Bibionidæ*, *Mycetophilidæ*, etc. The Nemestrinidæ is one of the *very* few instances among Diptera in which there have been *apparent* additions to the primitive venation. Other examples are found among the *Cyrtidæ*, *Bombyliidæ* (and *Asilidæ* possibly); every-

where else in Diptera specialization has been by *reduction*." (Litt. Sept. 17, 1908.)

The new species is named after Dr. Williston, in recognition of his important contributions to the knowledge of the Nemestrinidæ of North America.

According to Verrall's classification, the North American *Rhynchocephalus volaticus* Williston would go in *Nemestrina*; but no doubt the structure of the mouth-parts is more important in this family than any detail of the venation, and hence we are disposed to adhere to Williston's generic reference.

The following key separates the Tertiary and Recent genera of Nemestrinidæ found in the Palæarctic and Nearctic regions.

- |  |   |
|--|---|
| Proboscis long . . . . .   | 1.  |
| Proboscis short . . . . .  | 5.  |
| 1. Only two submarginal cells, the outer radiomedial cross-vein lacking; proboscis projecting anteriorly. (American Miocene) . . . . .   | <i>Palembolus</i> Scudder.                          |
| Three submarginal cells . . . . .  | 2.  |
| 2. Diagonal vein extending to wing-margin . . . . .  | 3.  |
| Diagonal vein not extending to wing-margin . . . . .   | 4.  |
| 3. Proboscis projecting anteriorly (Palæarctic).   |   |
| <i>Nemestrinus</i> Latr. 1802 ( <i>Nemestrina</i> Latr. 1809).   |   |
| Proboscis not projecting anteriorly (Florida)  |   |
| <i>Rhynchocephalus</i> subg. nov. <b>Nemestrinopsis</b> (type <i>R. volaticus</i> Will.).  |   |
| 4. A short subtriangular cell (between branches of media) adjacent to end of discal cell; longitudinal veins more or less uniting near apex of wing. (S. Europe; N. Africa) . . . . .                                  | <i>Fallenia</i> Meig.                               |
| Cell between branches of media open or closed, but always long; if longitudinal veins unite apically, it is always the branches of the media or of the cubitus with each other. (Russia; Persia; N. America) . . . . . | <i>Rhynchocephalus</i> Fisch.                       |
| 5. Second posterior cell divided into two by a vertical cross-nervure: first basal cell rather broadly truncate at end (American Miocene) . . . . .  | <i>Hirnoneurites</i> Ckll.                          |
| Second posterior cell not so divided . . . . .   | 6   |
| 6. Radial sector confluent with upper branch of media (second and upper branch of third veins confluent). (Spain; Africa) . . . . .  | <i>Symmictus</i> Lw. <sup>1</sup>                   |
| Radial sector not thus confluent with media . . . . .  | 7.  |
| 7. Outer radiomedial cross-vein absent; anal cell widely open (Central Europe and Transcaspia) . . . . .   | <i>Hirnoneura</i> Meig.                             |
| Outer radiomedial cross-vein present; anal cell narrowly open or closed (N. America, Miocene and Recent) . . . . .   | <i>Hirnoneura</i> subg. <i>Parasymmictus</i> Bigot. |

It is a question whether *Nemestrinopsis* and *Parasymmictus* (in the broad sense here employed) should not be regarded as valid genera. I give a check-list of the North American species. Those marked with an

<sup>1</sup> A figure loaned to me by Dr. Williston, labelled *Colax*, shows essentially the same venation, but the second submarginal cell is open, whereas in *Symmictus* it is closed.

asterisk are Miocene. It is evident that the family was formerly much more abundant in this country than at present, as more than twice as many are known from Florissant as from any single region to-day.

PALEMBOLUS Scudd.

\**florigerus* Scudd.

RHYNCHOCEPHALUS Fisch.

*sackeni* Willist. (W. States).

*subnitens* Ckll. (Kansas).

*volaticus* Willist. (Florida).

HIRMONEURITES Ckll.

\**willistoni* Ckll.

HIRMONEURA Meig.

*clausa* Osten Sacken (Texas).

*brevirostris* Macq. (Yucatan).

*psilotes* Osten Sacken (Mexico).

*flavipes* Willist.

*texana* Ckll. (Texas).

\**vulcanica* Ckll.

\**melanderi* Ckll.

\**occlator* Ckll.

STRATIOMYIDÆ.

**Nemotelus prisculus** sp. nov.

♀. Length about or nearly 10 mm.; wing about 8; width of abdomen in middle about 4; head seen from above shaped as in *Nemotelus*, the snout well developed, the antennæ probably normal but not well preserved; eyes bare, 730  $\mu$  apart; thorax black, with black hair, which is sparse but rather long; abdomen broad, tapering at apex, as in *Nemotelus*, black, with the apical two segments ferruginous, no light markings visible, but as only fragments of the surface are preserved, they cannot be positively said to have been absent; hind legs extending about 1½ mm. beyond

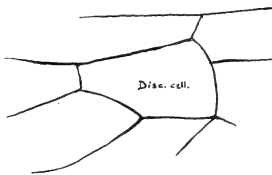


Fig. 4. *Nemotelus prisculus* sp. nov.

end of abdomen, when held in normal position; wings reddish, darker about end of costal cell and a little beyond; venation essentially as in *Hermetia*. On the wing alone, I should place this in *Hermetia*, but the form of the head and body are not at all as in *Hermetia*, but agree well with *Nemotelus*. Possibly the insect is deserving of a separate generic name. In the description of the wing, the measurements are in microns. End of first vein about 1360 from end of upper branch of third; end of upper branch of third about 680 from end of lower branch; end of lower branch of third about 1020 (obliquely) from apex of wing; discal cell on second posterior about 170; end of anal cell to wing margin about 170; width of third posterior cell toward apex about 510. Compared with *N. uliginosus* (cf. Verrall, British Flies, V, p. 56) the following differences are apparent:

- (1.) Outer nervures strong, as in *Hermetia*.
- (2.) Third vein approaching apex of wing, the end of its lower branch much nearer to apex than to end of first vein. This also agrees rather with *Hermetia*.
- (3.) Discal cell shaped essentially as in *Hermetia*, that is more triangular or subpyriform than in *N. uliginosus*.
- (4.) Third posterior cell slightly narrowed apically, also as in *Hermetia*.
- (5.) Fifth posterior cell only touching discal at its upper corner, instead of being broadly joined with it. The anal, on the other hand, agrees better with *N.*



*uliginosus*, being very broad. *Nemotelus nigrinus* is even less like the fossil than *N. uliginosus*.

*Hab.*—Miocene shales of Florissant, 1909 (*George Sternberg*). *Am. Mus. Nat. Hist.*, No. 10181.

By comparison with other genera, it becomes evident that *Hermetia* has a more primitive or less modified venation than *Nemotelus*; hence *N. prisculus* may be regarded as a primitive member of its genus. The living genus is a large one, and it may be that some of its species have characters approaching those of the fossil. *Nemotelus canadensis* Lw. occurs in Colorado to-day. In New Mexico I have taken *N. canadensis* Lw. at Albuquerque, and *N. unicolor* Lw. at Las Vegas.

*N. prisculus* is the first Stratiomyid to be described from the Florissant shales. It has no resemblance to the Green River (Eocene) species described by Scudder. Meunier has described a genus *Hermetiella* from Baltic Amber, but it is not at all like either *Hermetia* or the fossil now described. Except for the antennæ, Meunier's genus appears to resemble the Beridinae.

#### BOMBYLIIDÆ.

##### ***Pachysystropus condemnatus* sp. nov.**

Abdomen dark colored, about 10 mm. long, 3 wide, minutely hairy, the hair at apices of last two segments quite long; dorsal sclerites of all the segments except the two last produced anterolaterally into rounded lobes, which are very prominent on the anterior segments, and become less so posteriorly, the result being that the sides of the abdomen, seen from above, appear coarsely obtusely serrate (in *P. rohweri* the lateral anterior corners of the first three segments project); hind femora stout and hairy; wing about  $8\frac{1}{2}$  mm. long, hyaline, nervures ferruginous; venation similar to that of *P. rohweri*, except that the upper branch of the third vein is strongly elbowed, without showing any sign of a cross-vein to second, while the anal cell is closed about  $120\ \mu$  from the margin, and the first posterior about the same distance. The anterior cross-vein is  $935\ \mu$  from apex and  $1410$  from base of discal cell. The rock is broken so that the head and thorax are lost.

*Hab.*—Miocene shales of Florissant, Colorado (*Univ. of Colo. Exped.*).

In Verrall's arrangement this falls in the Toxopharinae rather than the Systropinae, on account of the hair on the abdomen. In Williston's table the genus runs to *Dolichomyia*, from which it is quite distinct. In having a closed anal cell and only three posteriors it agrees with *Toxophora*, but it is otherwise different, having a closed first posterior and only two submarginals.

It will be useful to give a key for the separation of the Florissant Bombyliid genera.

- |    |  |                         |
|----|--|-------------------------|
|    | First posterior cell closed; only three posterior cells . . .  | <i>Pachysystropus</i> . |
|    | First posterior cell open . . . . .  | 1.                      |
| 1. | Three posterior cells; two submarginals . . . . .  | <i>Melanderella</i> .   |
|    | Four posterior cells . . . . .   | 2.                      |
| 2. | End of second vein its most apical point; two submarginals .   | <i>Lithocosmus</i> .    |
|    | End of second vein not its most apical point, the vein bending over apically,<br>so that its outer angle with wing-margin is less than a right angle . . . . | 3.                      |
| 3. | Upper branch of third vein elbowed, without any projecting stump   | <i>Megacosmus</i> .     |
|    | Upper branch of third vein angled, with a projecting stump .   | <i>Alepidophora</i> .   |
- For a tabular statement of the differences between the last two, see Bull. Amer. Mus. Nat. Hist., XXVI, p. 10.

CRUSTACEA.

## OSTRACODA.

**Cypris florissantensis** sp. nov.

Shell about 850  $\mu$  long and 510 deep, or sometimes rather larger; surface minutely granular; shape nearly as in *C. virens*. Similar to the European Miocene species *C. faba* Desm., but not so long in proportion to its depth. (I have seen Eningen material of *C. faba* in the museum at Constance.)

*Hab.*—Miocene shales of Florissant, very common. Now described from specimens on the type case of *Indusia cypridis*. Am. Mus. Nat. Hist., No. 10190.

This is the only Crustacean known from Florissant. I have had it for a number of years, but did not publish it because I had sent specimens to Mr. R. W. Sharpe, and hoped that he would prepare an account of it.

## Article XXVI.—THE PHYLOGENY OF THE FELIDÆ.

BY W. D. MATTHEW.

Fossil members of the cat family have been found in all the principal horizons of the Middle and Later Tertiary, and in the Pleistocene. Some of them equal or exceed in size the largest living species; none are smaller than the modern domestic cat. The great majority, including all of the more ancient species, are distinguished by greater or less enlargement of the upper canines into long curved and flattened tusks. These are the Sabre-tooth Tigers, well known to popular science. True cats in which the upper and lower canines are of nearly equal size, are not known as fossils until the Pliocene.

The oldest of the Machærodonts or Sabre-tooth Tigers are found in the Lower Oligocene of Europe and North America. In both countries these oldest forms are comparatively large animals, ranging from leopard to lynx size, and are clearly divided into two series, one with very long but slender canines, protected by a deep flange on the lower jaw, the other with shorter canines and much less flange on the jaw. The best known member of the first series is *Hoplophoneus*, of the second *Dinictis*, both represented in American Museums by several complete skeletons and many skulls from the White River and John Day Oligocene. The European genera *Eusmilus* and *Ælurictis* are closely related to the better known American forms.

No Eocene carnivora are known from which either of these Oligocene Sabre-tooths can be derived. Their supposed derivation (Wortman, 1892) from *Palæonictis* (Lower Eocene) through *Ælurotherium* (Middle Eocene) has been shown (Matthew, 1909) to be erroneous, *Ælurotherium* being founded on the milk dentition of *Patriofelis*, which like *Palæonictis*, is a member of the Oxyænidæ, a family of Creodonts in which the carnassial specialization affects a different pair of teeth ( $\frac{m_1^1}{m_2}$ ) from the pair involved in the specialization of all modern carnivora ( $\frac{p_1^1}{m_1}$ ). The earlier derivation from *Oxyæna* itself (Cope, 1880) is invalid for the same reason. *Proælurus* has been regarded by some authors as representing an early stage in the structural evolution of the cats, but it is less ancient than *Hoplophoneus* or *Dinictis* and therefore of no genetic significance, and is furthermore probably rather of Mustelid than Felid affinities.

The successors of *Dinictis* and *Hoplophoneus* in the Upper Oligocene are *Nimravus* and *Eusmilus*, closely related to their predecessors, with somewhat more specialized dentition; but in *Nimravus* the upper canines

are shorter than in *Dinictis*.<sup>1</sup> In the Miocene, *Pseudaelurus*<sup>2</sup> and *Machærodus* are the probable successors; both genera are imperfectly known and chiefly from European specimens. In the Pleistocene of North America,<sup>3</sup> and in the Pliocene and Pleistocene of Europe, we find true cats of the genus *Felis*, and gigantic and highly specialized sabre-teeth of which *Smilodon* is the best known representative.

While the derivation of the great Pleistocene Sabre-teeth from the Oligocene *Hoplophoneus* has been generally accepted, the exact relationship of the less specialized series of primitive sabre-teeth represented by *Dinictis*, has not I think been correctly appreciated. They have been regarded as early stages in the specialization of the sabre-tooth series, while the true cats have been derived from undiscovered Oligocene Felidæ with normal canines. The evidence appears, however, to indicate that the *Dinictis* phylum led directly into the modern Felidæ, the canines having reverted from the almost unique machærodont specialization to the normal type of carnivorous mammals. The series *Dinictis-Nimravus-Pseudaelurus-Felis* are in direct succession, structurally and geologically.

The difference in length of canines between the Dinictid and Hoplophoneid series of sabre-teeth is correlated with a large number of well marked and constant distinctions in the structure of teeth, skull and skeleton. In every one of these characters the Dinictid series agrees with the true cats or is structurally ancestral to them; while the Hoplophoneid series agrees with the great Pleistocene sabre-teeth or is ancestral to them.

I. The dentition in the two series is as follows:

<i>Felis</i>	$\frac{3.1.3-2.1}{3.1.2.1}$	<i>Smilodon</i>	$\frac{3.1.2-1}{3.1.2-1.1}$
<i>Pseudaelurus</i>	$\frac{3.1.3.1}{3.1.3-2.1}$	<i>Machærodus</i>	$\frac{3.1.2.1}{3.1.2.1}$
<i>Nimravus</i>	$\frac{3.1.4-3.1}{3.1.3-2.2-1}$	<i>Hoplophoneus</i>	$\frac{3.1.2-3.1}{3.1.2.1}$
<i>Dinictis</i>	$\frac{3.1.4-3.1}{3.1.3.2}$		

### *Carnassial Specialization and Molar Reduction.*

II. The construction of the carnassials affords a ready means of distinguishing the two series. In *Dinictis* and its successors the two principal blades of the upper and lower carnassial are separated by a deep, sharply

<sup>1</sup> *Archaelurus* is not generically separable from *Nimravus*, auct. J. C. Merriam, 1906. *Pogonodon* I regard as a distinct subgenus.

<sup>2</sup> *P. quadridentatus* (type) of the Middle Miocene (Sansan) of Europe, *P. intrepidus* of the Upper, and *P. sp. indesc.* of the Middle Miocene of North America, but exclusive of *P. edwardsi* of the Phosphorites, which I refer to *Ælurictis*.

<sup>3</sup> *Felis hillanus* of the North American Pliocene (Blanco) is not generically determinable as the dentition is unknown. The same remark applies to all other recorded occurrences of *Felis* in the American Miocene or Pliocene.

cut notch, identical in type with that in all modern felines. In the *Hoplophoneid* series the notch in the upper carnassial is shallower, and the blades more nearly continuous.

In the upper carnassial of *Dinictis* the external blades are composed of two cusps (paracone and metacone), as in the *Canidæ* and *Mustelidæ* and most primitive carnivora; there is also a distinct internal cusp (protocone). In the successive stages a third antero-external cusp (parastyle) is developed,

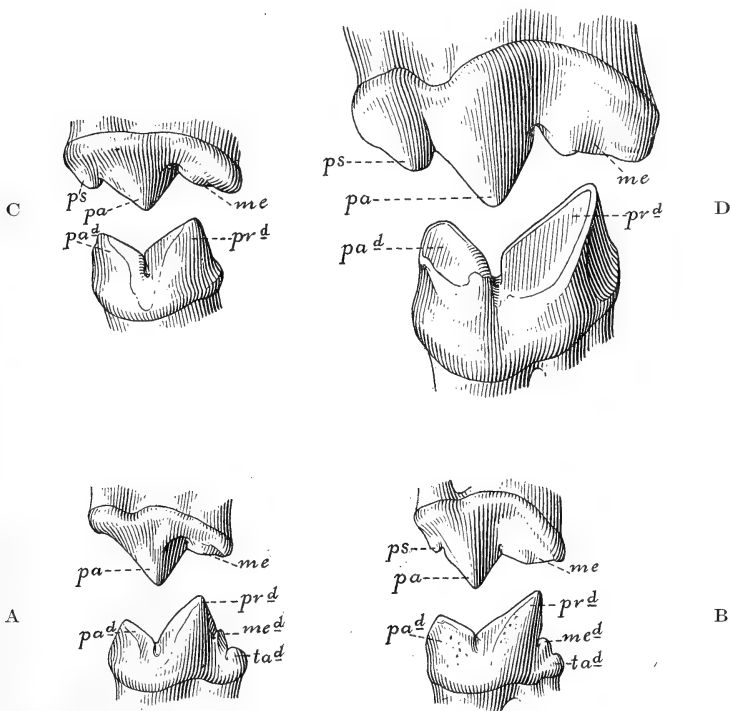


Fig. 1. Carnassials of Felines and Machærodonts. A, *Dinictis*; B, *Hoplophoneus*; C, *Felis*; D, *Smilodon*. All natural size. Upper carnassials: *me*, metacone; *pa*, paracone; *ps*, parastyle. Lower carnassials: *me<sup>d</sup>*, metaconid; *pa<sup>d</sup>*, paraconid; *pr<sup>d</sup>*, protoconid; *ta<sup>d</sup>*, talonid or "heel." From the specimens illustrated in Figs. 10, 13, 12, and 15.

rudimentary in *Pseudælorus*, distinct in *Felis*, while the internal cusp becomes less separate, although still retained. In *Hoplophoneus* we find in addition to the two principal external cusps, a small antero-external (parastyle) which develops to large size in *Machærodus*, and in *Smilodon* a fourth external cusp is frequently developed in front of it; but these cusps are always more closely connected with the paracone, forming more of a continuous blade, than in the *Dinictis-Felis* series. The inner cusp is

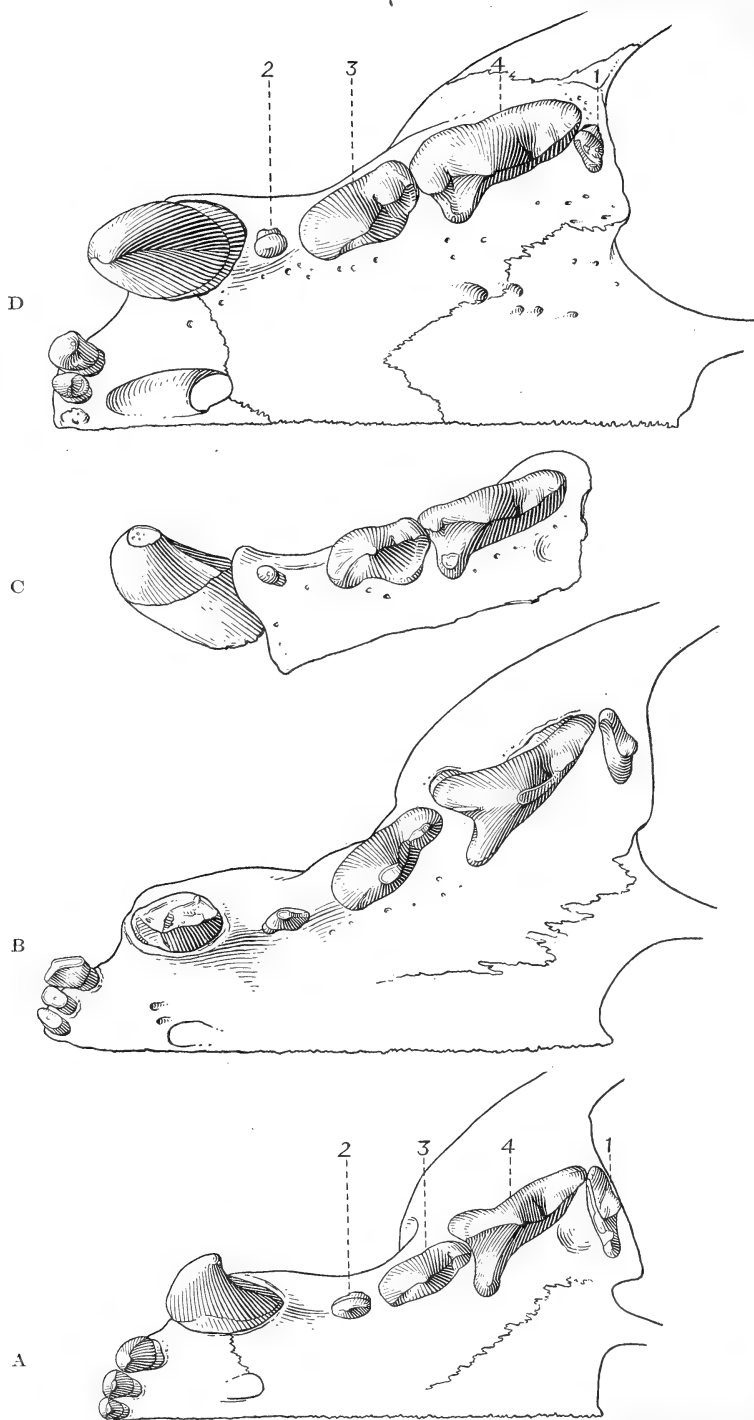


Fig. 2. Feline series, upper jaw. A, *Dinictis*, No. 8777, Middle Oligocene; B, *Nimravus*, No. 6931, Upper Oligocene; C, *Pseudaelurus* (after Filhol), Middle Miocene; D, *Felis*, No. 11082, Recent. All natural size.

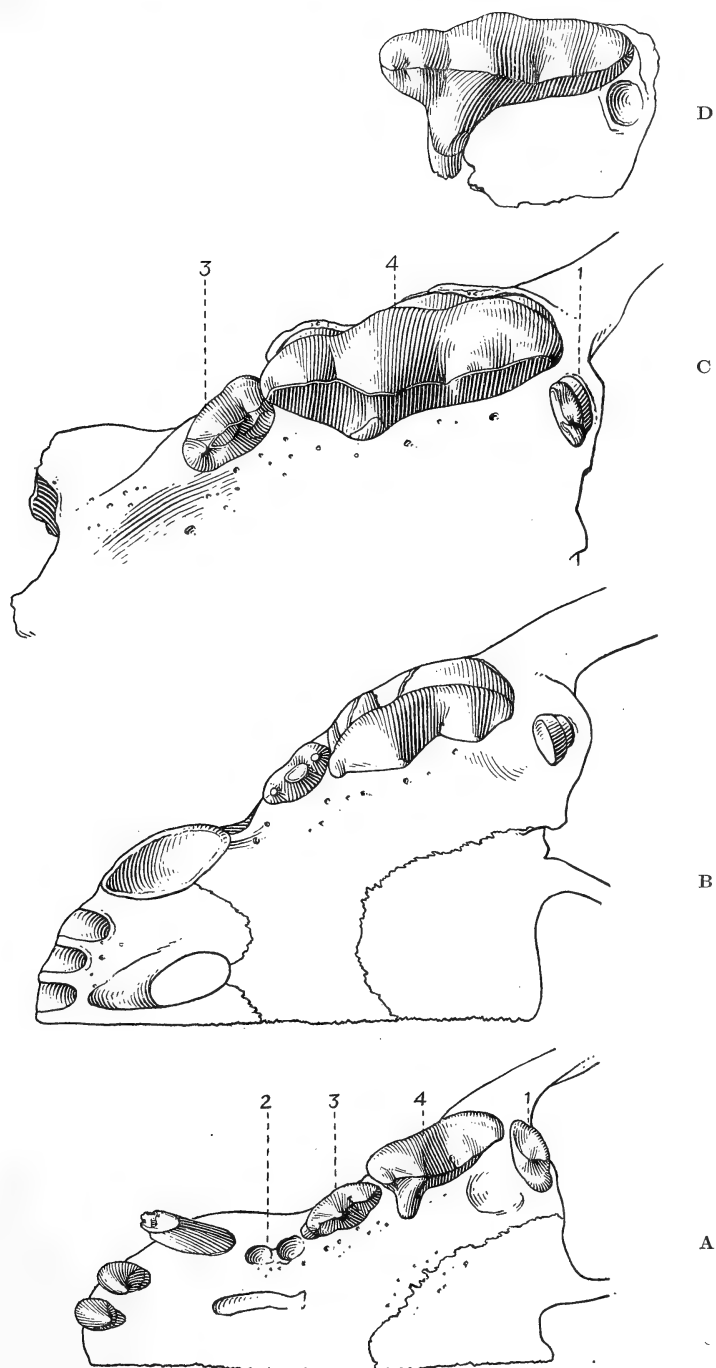


Fig. 3. Machærodont series, upper jaws. A, *Hoplophoneus*, No. 9764, Oligocene; B, *Machærodus* (after Filhol), Miocene; C, *Smilodon*, No. 14349, Pleistocene; D, *Trucifelis*, No. 10395, Pleistocene. All natural size.

always vestigial or absent in the *Hoplophoneus-Smilodon* series, although there is usually an inner root to the carnassial.

The lower carnassial of *Dinictis* has a distinct heel and usually a vestigial metaconid. In *Nimravus* (and *Elurictis*) the metaconid has entirely disappeared but the heel is still distinct. In *Pseudaelurus* the heel is vestigial, and it has entirely disappeared in *Felis*. *Dinictis* has also a vestigial  $m_2$ , minute to absent in its successor *Nimravus*, absent in the later stages. *Hoplophoneus* has a very small vestigial heel and metaconid on the lower carnassial, but no  $m_2$ ; this heel and metaconid have vanished in all the later stages of the machærodont phylum.

The upper molar is reduced in both series *pari passu*, from a fairly well developed transverse cutting tooth to an oval vestigial tooth of very small size.

III. *Premolar Reduction.* The mere enumeration of the premolars fails to show the real difference in the premolar dentition of the two phyla. In the Dinictid-Feline phylum the essential functional premolars are two of subequal size in the lower jaw, and one large premolar in front of the upper carnassial opposes them. In the Machærodont phylum there is but one large premolar in the lower jaw and a small premolar in front of the upper carnassial. The remaining premolars are vestigial and successively disappear.

In the Dinictid phylum,  $p^1$  is vestigial or absent in *Dinictis* and *Nimravus*, absent in *Pseudaelurus* and *Felis*.  $P^2$  is small in *Dinictis*, vestigial in *Nimravus* and *Pseudaelurus*, vestigial or absent in *Felis*.  $P_2$  is vestigial in *Dinictis*, vestigial or absent in *Nimravus* and *Pseudaelurus*, absent in *Felis*.

In the Machærodont phylum,  $p^2$  is vestigial or absent in *Hoplophoneus*, usually absent in the later stages.  $P_3$  is small in *Hoplophoneus*, vestigial in *Machærodus* (absent in the later species), usually absent in *Smilodon*.

IV. *Proportions of the Skull.* *Dinictis* and its successors have throughout the characteristic feline outlines and proportions in the skull. The frontal region is high, the occiput rather broad and low, the basicranial region wide and flat and nearly in a plane with the palate; the glenoid articulations are nearly in a plane with the basicranial surface. When viewed with the alveolar borders in the horizontal plane the skull is usually highest at the frontal region, sloping downwards towards the occiput and muzzle.<sup>1</sup>

In the Hoplophoneid phylum the skull, when oriented in the same way, is highest at the occiput, with a convex downward slope from that point

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<sup>1</sup> In the accompanying drawings the skulls are referred to a horizontal plane passing through the premaxillary border and the glenoid articulations for the lower jaw. This is approximately the plane of the alveolar borders and of the hard palate.



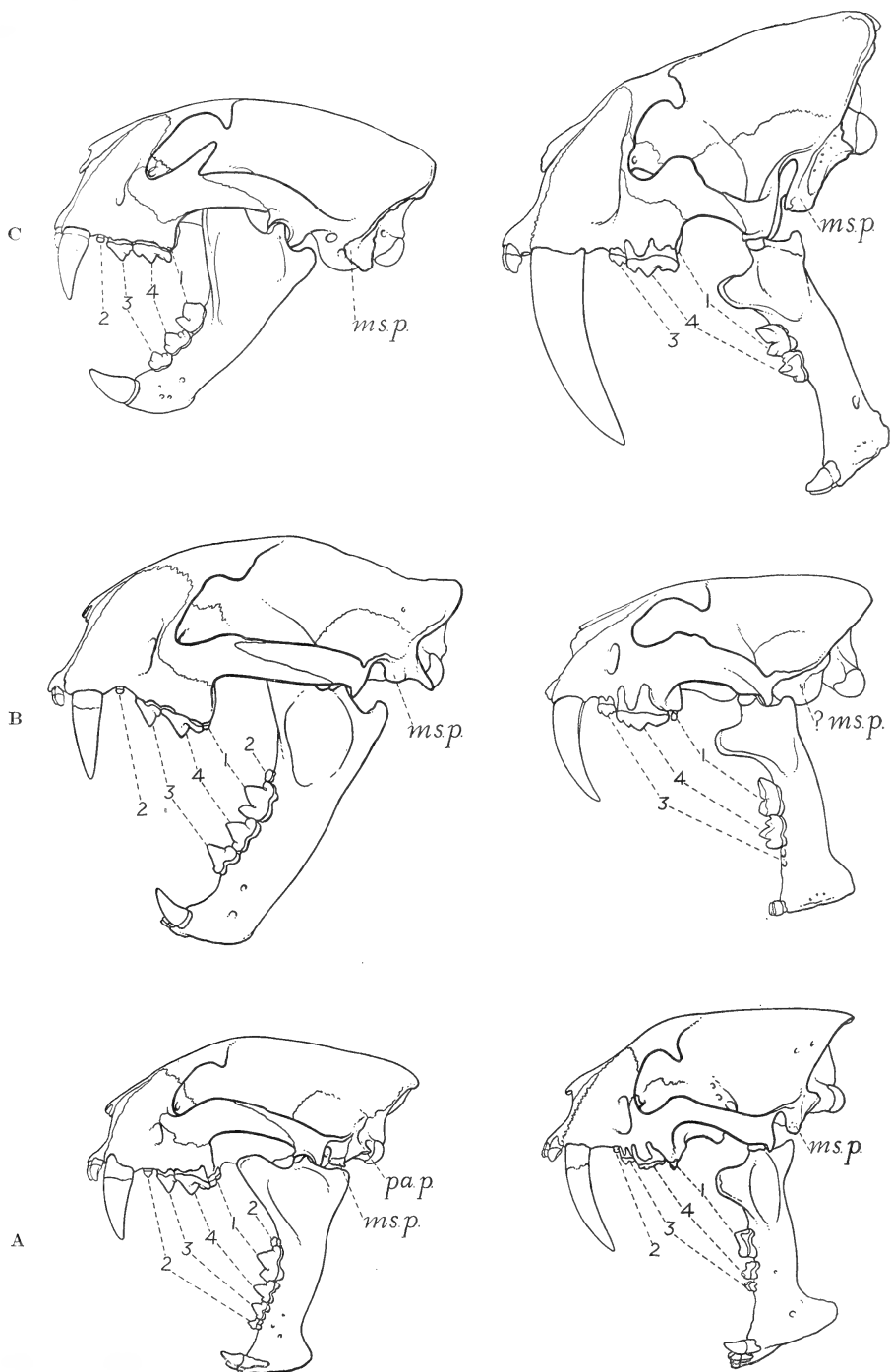


Fig. 4. Skulls of Felines and Machærodonts. A, *Dinictis* and *Hoplophoneus*; B, *Nimraius* and *Machærodus*; C, *Felis* and *Smilodon*.

to the nasals. The condyles and basicranial region lie in a considerably higher plane than the palate, and the glenoid articulations are much below the level of the basicranial plane. The occiput is comparatively high and narrow, the condyles very prominent and convex, and their facets continued forward upon the inferior surface of the basicranium. The zygomatic arches are much shorter than in the Dinictid-Feline phylum and are widest at the glenoid articulations. The brain-case is relatively much smaller.

V. *Development of the Mastoid Process.* In *Dinictis* this process is distinct and prominent, but small. In *Nimravus* it is less prominent. In *Pseudaelurus* this part of the skull is unknown. In the modern cats the mastoid process is merely a small convex rugosity. On the other hand in the machærodont series it is at first, in *Hoplophoneus*, of larger size than in *Dinictis* and more prominent, but similar in form and position. In the successive stages of *Machærodus* and *Smilodon* it progressively increases in size and prominence, encroaching and projecting more and more towards the postglenoid process, and reaching its maximum both of size and of distance in front of the occipital condyles in *Smilodon*.

The development of this process is directly dependent upon the greater or less size of the *cleido-mastoid* muscle, which originates at the tip of the mastoid process and is attached to the anterior border of the clavicle. Closely associated with this muscle in function is the *sterno-mastoid*, originating upon the postero-lateral exposure of the mastoid bone and attaching to the anterior end of the sternum. The function of these muscles is to pull the head forward and downward upon the neck. In the cats they are quite small, and their leverage, measured by the distance of the mastoid process in front of the occipital condyles, is short. In *Smilodon* the scars of their origin, the cleido-mastoid upon the tip, the sterno-mastoid upon the side of the mastoid process (the origin of the muscle having apparently moved downward and forward along the mastoid exposure) shows them to have been (1) enormously powerful muscles, with (2) much greater leverage for direct downward movement of the skull than in the cat. This enabled the Sabre-tooth to strike a (1) tremendously powerful, (2) quick downward blow with the great canine tusks.

Coördinated with the development of the sterno-cleido-mastoid muscles is a corresponding development of the scalene muscles of the neck, passing from the transverse processes of the cervicals to the lower ends of the anterior ribs. In the Machærodont series the origins of these muscles are progressively enlarged, as indicated by the transverse processes, which are progressively converted into long stout spines, directed backward, downward and outward; in the feline series they are progressively reduced,

the transverse processes reverting to the normal type of a thin flat plate of bone. Usually these scalene muscles chiefly serve to draw the ribs forward and upward and so expand the chest; but in combination with other body-muscles they would equally serve to pull the neck downwards, and this I take to have been their chief function in *Machærodonts*.

VI. *Basicranial Characters*. Both *Dinictis* and *Hoplophoneus* have a

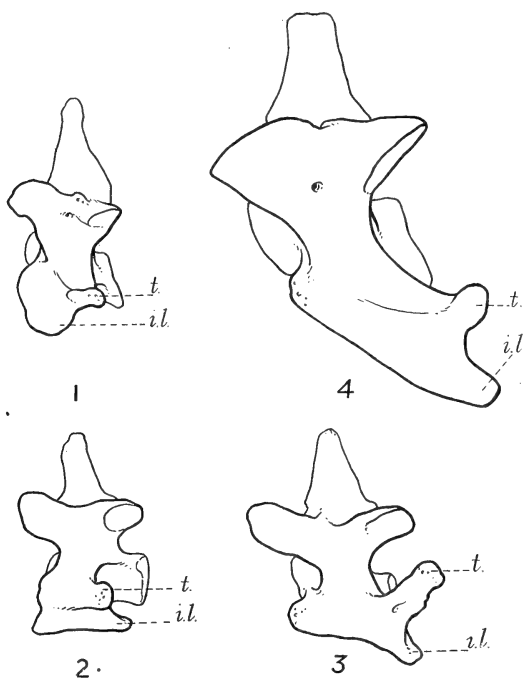


Fig. 5. Fifth cervical vertebra in Felines and *Machærodonts*. 1, *Dinictis*; 2, *Felis*; 3, *Hoplophoneus*; 4, *Smilodon*. All one half natural size. T, transverse process; i-l., inferior lamina.

number of important features in the basicranial region, in which they differ from either *Smilodon* or the modern felines, and approach the more generalized or primitive carnivora.

1. The condylar foramen is always, and the carotid canal generally, wholly distinct from the posterior lacerate (jugular) foramen.
2. An alisphenoid canal is present.
3. A postglenoid foramen is present.
4. The paroccipital process is directed backwards and free from the tympanic bulla.
5. The tympanic bulla is never completely ossified.

All of these are features characteristic of the Eocene Creodonta.<sup>1</sup> Some of them are retained in one or another group of the modern carnivora. All of them are lost by the Pliocene, Pleistocene or modern cats and Machærodonts.

Upon these primitive basicranial characters and upon additional primitive characters observable in the skeleton Cope based his family Nimravidae. His characterization of them as False Sabre Teeth shows however that he did not regard them as constituting simply a primitive group from which both felines and machærodonts are derived — the view taken here of their relations.

The basicranial characters of the four genera, *Dinictis*, *Hoplophoneus*, *Felis* and *Smilodon*, are contrasted in the accompanying diagram. It is singular, in view of the very marked and profound basicranial distinctions between *Smilodon* and *Felis*, and the importance which has been attached to this region of the skull in the classification of the carnivora, that there should be so few published figures or descriptions and such slight reference to these characters in the later Machærodonts.<sup>2</sup> The magnificent series of skulls and skeletons of *Smilodon* recently obtained near Los Angeles, California, affords opportunity for an adequate morphologic and adaptive study of this unique and remarkable carnivore. On this account it is not advisable at present to give any detailed discussion of its peculiarities. It represents a highly specialized condition derived from the primitive "Nimravid" type, paralleling the true Felines in a few features, wholly distinct or divergent in others.

VII. *Lower Jaw.* The coronoid process is of moderate height in *Dinictis*, progressively higher and more recurved in *Nimravus*, *Pseudælurus* and *Felis*. In *Hoplophoneus* it is much shorter and smaller, and progressively further reduced in *Machærodus* and *Smilodon*. These changes are directly correlated with the reduction and outward twisting of the angle, and with changes in the articulation of the jaw *allowing a progressively wider gape* in the Machærodont phylum, corresponding to the elongation of the canine; while in the Feline phylum the gape is progressively reduced and the articulation of the jaw is strengthened and tightened, to enable the upper and lower canines to bite powerfully in opposition.

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<sup>1</sup> See Matthew, 1909, Carnivora and Insectivora of the Bridger Basin. Mem. A. M. N. H., Vol. IX. pt. vi.

<sup>2</sup> Flower, Mivart and Burmeister refer to them only in a very slight and superficial way; Winge makes a somewhat more definite reference to the peculiar mastoid specialization; but nowhere do I find any reference to the peculiar form and construction of the bulla, quite unlike *Felis* or any of the living Æluroids, and even more unlike the Arctoids. The inclusion of this genus in the Æluroides makes it necessary to modify the definition of the group very materially. Yet there seems to be no doubt that its affinities are really with Æluroides.

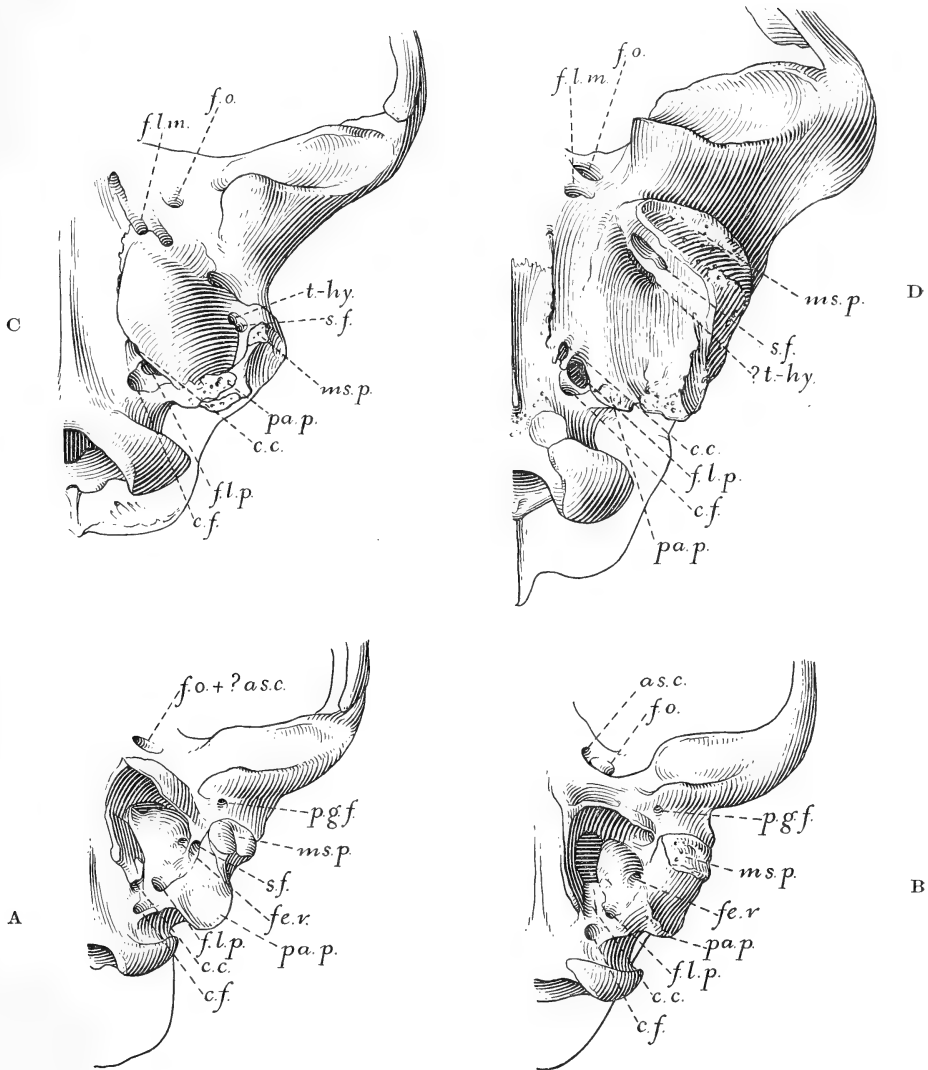


Fig. 6. Basicranial region in Felines and Machærodonts. A, *Dinictis*,  $\times \frac{3}{2}$ ; B, *Hoplophoneus*,  $\times \frac{3}{2}$ ; C, *Felis*,  $\times \frac{3}{2}$ ; D, *Smilodon*,  $\times \frac{1}{2}$ . As. c., alisphenoid canal; c. c., carotid canal; c. f., condylar foramen; fe. r., fenestra rotunda; f. l. m., foramen lacerum medius; f. l. p., foramen lacerum posterius; f. o., foramen ovale; ms. p., mastoid process; pa. p., paroccipital process; p. g. f., postglenoid foramen; s. f., stylomastoid foramen; t-hy., tympanohyal pit.

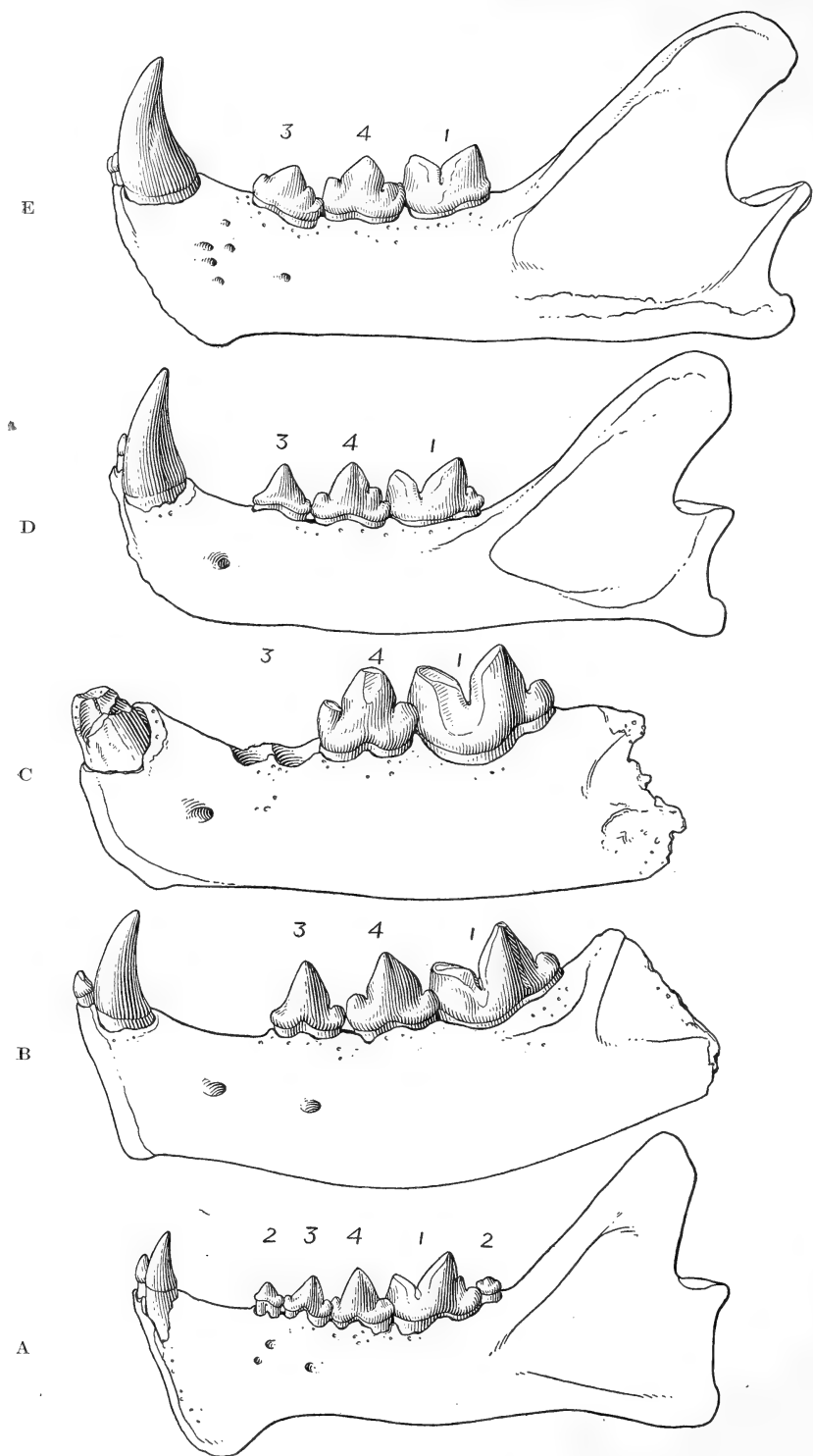


Fig. 7. Feline series, lower jaw. A, *Dinictis*, No. 8777, Middle Oligocene; B, *Nimravus*, No. 6935, Upper Oligocene; C, *Nimravus*, No. 12882, Lower Miocene; D, *Pseudaelurus*, No. 10396, Upper Miocene; E, *Felis*, No. 11082, Recent. All two-thirds natural size.

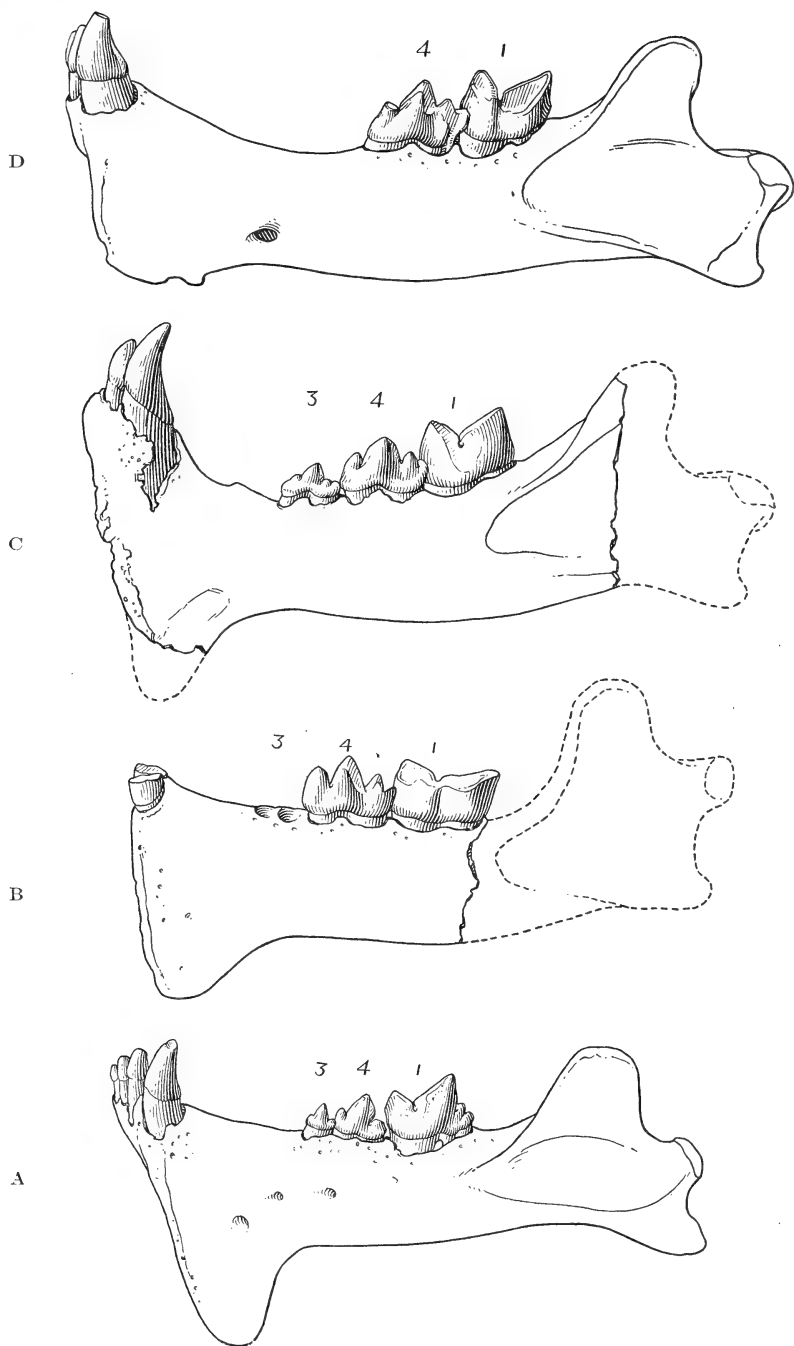


Fig. 8. Machærodont series, lower jaw. A, *Hoplophoneus*, No. 11858,  $\times \frac{3}{2}$ , Oligocene; B, *Machærodus palmidens* (after Filhol and Brule) Miocene; C, *M. megantereon* (after Blainville), Pliocene; D, *Smilodon*, No. 14349,  $\times \frac{1}{2}$ , Pleistocene.

The lower canines are progressively larger and more powerful in the feline phylum, progressively smaller and weaker in the machærodont phylum becoming functionally a part of the incisor series.

In considering the significance of these peculiarities in the form and relations of the lower jaw, we may call to mind a few points in regard to the action of the principal jaw muscles.

1. The *temporalis* is the most powerful jaw muscle in Carnivora. It originates from the sagittal and occipital crests and surface of the brain-case, and is attached to the tip and upper part of the coronoid process. Its action is to close the jaws, and it is most effective when the jaw is widely gaping.

2. The *masseter* is the principal jaw muscle in animals with grinding teeth, but is of less importance among the carnivora. It originates on the zygomatic arch (also in front of the arch in rodents and ungulates) and is inserted upon the external side of the jaw below the coronoid process. Its action is to close the jaws and it is most effective when the jaws are nearly closed.

3. The *pterygoid* muscles originate on the inner and outer side of the pterygoids and adjoining parts of skull and are inserted on the inner side of the angle of the jaw in front of and below the condyle. They also serve to close the jaw, acting mainly with the masseter, but with shorter leverage.

4. The *digastric* attaches to the paroccipital process of the skull and to the inferior border of the lower jaw behind the symphysis, and serves to open the jaws.

An inspection of the relations of these muscles shows that in the sabre-tooth tigers as compared with true cats:

1. Owing to the height between occiput and glenoid articulation, and the short low coronoid process the temporalis was a much longer muscle with much less leverage.

2. The shortness and posterior position of the zygoma, and the weakness of its anterior part, and the more inferior and posterior position of the masseteric fossa, indicate that the masseter was relatively weak and its leverage small.

3. The shortness and outward twisting of the angle increases the length, while decreasing the leverage, of the pterygoid muscles.

4. The relatively high plane of the basicranial region and the downward projections of the glenoid region, with the backward direction of the paroccipital process, serve to considerably increase the length of the digastric muscle, and to enable it to act more effectively when the jaw is very widely gaped.

It will appear therefore that the muscles which close the jaw were of



greater length and less leverage in the sabre-teeth than in normal carnivora, and this is especially true of the temporalis whose chief efficiency is when the jaw is gaping widely. It is a well known and obvious fact in animal mechanics that muscles of great length and small leverage permit

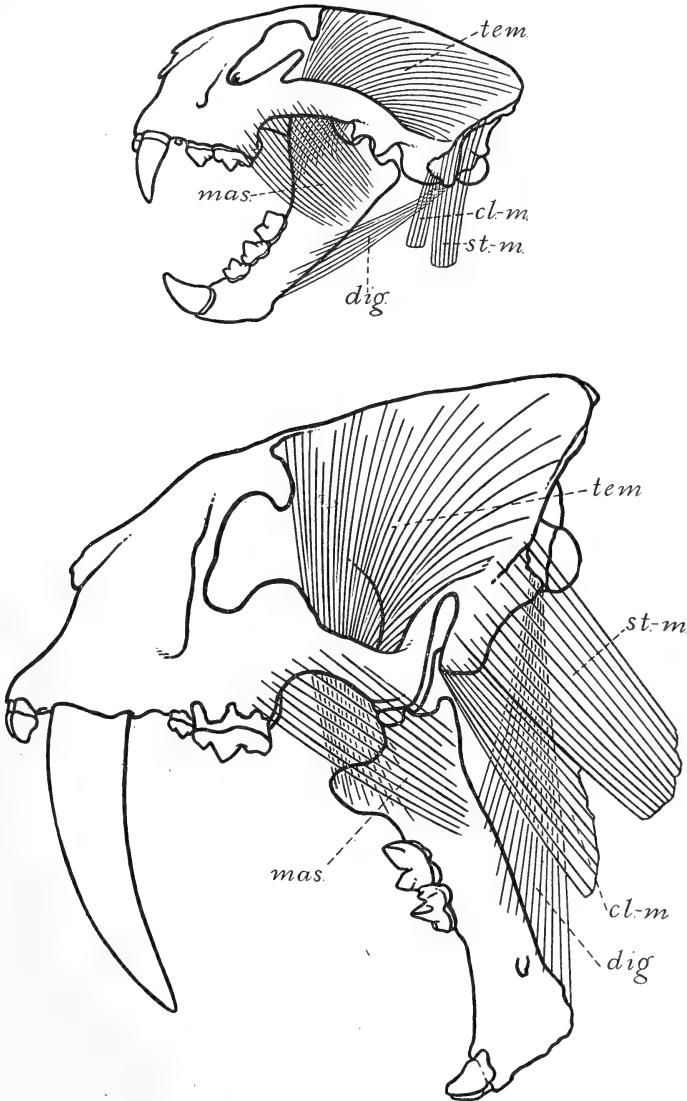


Fig. 9. *Smilodon* and *Felis*. Diagram to show the relations of certain muscles. *Cl-m.*, cleidomastoid; *dig.*, digastric; *mas.*, masseter; *st-m.*, sternomastoid; *tem.*, temporalis. The skulls are one-fourth natural size, the same specimens shown in Figs. 12 and 15.

an extensive range of motion but lack power; while short muscles of greater leverage are more powerful but limit the range of movement. As a result of the peculiarities cited, the same amount of stretching in the muscles which close the sabre-tooth jaw would permit of a much wider gape than is possible in normal carnivores. We see also that the digastric could draw the jaws much wider open before reaching its limit of contraction.

The gape of the jaws is also limited in normal carnivora by the projection of the angle, which strikes against the posterior surface of the postglenoid process with any attempt to open the jaws beyond  $80^{\circ}$  to  $90^{\circ}$ . But in the Sabre-tooths the outward twisting of the angle prevents its interfering in this way, and the jaws may be swung backward to  $150^{\circ}$ , when the condyle begins to lift out of the glenoid fossa.

A further adjustment in adaptation to the wider gape of the jaw is seen in the prominence and convexity of the occipital condyles. This enabled the head to be thrown farther back on the neck than in modern Felidæ, enabling the jaws to gape wider without interfering with the front of the neck.

Many other adjustments would indeed be necessary in the soft anatomy of the head and neck, to permit of the extreme width of gape necessary for the proper operation of the great tusks of the Machærodine series. But inasmuch as all the adjustments which would leave clear traces in the proportions and construction of the skull are shown to have been present, it seems a safe inference that those which would not leave such traces were likewise present.

VIII. *Proportions of the limbs.* In the Dinictid series the limbs are proportioned much as in the modern felines. In the machærodont series they are much shorter and more robust, approximating the proportions of *Smilodon*.

IX. *Construction of the Feet.* In the primitive members of both series the fore and hind feet are functionally five-toed. In *Dinictis*, however, the inner digit is proportionally more slender than the others, especially in the hind foot. In *Nimravus* the reduction of the inner digit of the hind foot is carried a little further; in *Pseudælurus* the construction of the feet is not known; in *Felis* the inner digit is vestigial in the hind foot, large but short in the fore foot. The Machærodont phylum, on the other hand, retains the primitive pentadactyl construction even in the hind foot, and in the fore foot the first digit is relatively stouter in all members of the phylum, and progressively so from *Hoplophoneus* to *Smilodon*.

X. *Vertebræ, Ribs and Tail.* Both *Dinictis* and *Hoplophoneus* retain the primitive proportions of small dorsals, short ribs, long flexible lumbar region, long and heavy tail. In the modern cats these proportions are

preserved to a varying extent; the tail is never so heavy, and may be long or short; the ribs are somewhat longer. The latest of the Machærodonts, *Smilodon*, departs much farther than any of the true cats from this primitive type, in the long and somewhat flattened ribs, the short and relatively small lumbar, indicating loss of flexibility in this region, and in the greatly reduced tail, comparable to that of the bears. *Hoplophoneus* shows no especial approach towards this type in comparison with *Dinictis*, and in *Machærodus* the skeleton is imperfectly known.

There are numerous details in the construction of skull, jaws and skeleton which might be adduced in further support of the relationships here advocated. But the features noted appear to be the most important and to afford adequate evidence that *Dinictis* and *Hoplophoneus* should be regarded as the earliest known stages of two divergent series, one terminating in the true cats, the other in the great sabre-tooths of the Pleistocene.

#### ADAPTATION OF THE TWO PHYLA.

I suggested some years ago (1901) an explanation of the use of the sabre-tooth canine, regarding the animal as adapted to prey upon the thick-skinned, slow-moving pachyderms — rhinoceroses, suillines, proboscideans, etc., which were the dominant herbivora of the Tertiary period. The elongation of the canines was regarded as adapted to pierce the thick hides of these animals, the method of attack being to strike the head downward with the mouth wide open, and to rip or gash the prey so that it would bleed to death.

The evidence then given in support of this explanation appeared at the time to be sufficient, especially as it could be readily verified and extended by study of material and figures accessible to most students of fossil vertebrates in this country and in Europe. I do not know how generally it has been accepted, but some subsequent writers apparently hold to the old view that the Machærodonts used their canines with the mouth shut, and that they became extinct because they could not open their mouths wide enough to eat. Three eminent authorities (Herluf Winge, Max Weber, O. Abel) have questioned the correctness of the present theory, on the ground that the necessary gape to give play to the canines would cause too great a displacement of the muscles and other parts to be admissible; but none of these writers appears to have considered the proofs which I gave, that the jaws were especially and peculiarly adapted to permit this extreme gape without any undue displacement; nor have they offered any other explanation of the various data adduced in support of my hypothesis. The structural data are more or less fully restated in

the preceding part of this paper. I may add further certain environmental data which accord with it.

As already noted, the dominant and abundant large herbivora of the early and middle Tertiary were of the type which were grouped together by Cuvier as Pachyderms—thick-skinned, short-necked animals, powerful and well adapted for fighting, but not swift footed. During the later Tertiary such animals as the various types of ruminants and the horses became more and more abundant—thin skinned, long legged, slender necked, well adapted for speed, but much less powerful or well armed than the pachyderm type. Meantime the various phyla of pachyderms increased in size, strength, and defensive armor, but dropped off one by one, until now there are only a few survivors, the rhinoceroses, the elephants, tapirs and pigs, and these mostly of limited geographic distribution.

Now the larger cats prey upon the larger ruminants, and smaller cats upon small ruminants et al., and their usual method of attack is to fasten on the back of the animal and bite through the neck until they break or sever the backbone. They are not fitted to, and do not, prey upon such animals as the rhinoceros or the elephant. The great pachyderms have in fact no carnivorous enemies and are kept in check by other means, which are evidently more efficient.

Now if the theory here advocated of the use of the machærodont canine be correct, the sabre-teeths were peculiarly fitted to prey upon large pachyderms, which were well able to protect themselves from other carnivora. Instead of attempting to break or bite through the neck, they would gash or rip it until the animal succumbed. The early felids then, which were all comparatively large and very well armed for attack, were presumably specially adapted to prey upon the early large ungulates, and were all sabre-toothed, as these were mostly of pachyderm type. With the rise and dominance of the large light limbed ruminants and horses some of these early sabre-teeths were correlatively adapted into the modern type of felines; while other sabre-teeths, as the surviving pachyderm phyla became larger, thicker skinned, and more powerful, became progressively larger, more powerful and developed longer and heavier weapons to cope with and destroy them. The final extinction of the Machærodont phylum was probably largely conditioned by the growing scarcity and limited geographic range of the great pachyderms; but other factors must also have been concerned in it.

Another object in reiterating this discussion of the use of the Machærodont canine is to protest against the use of *Smilodon* as an example of the extinction of a race through over-specialization *per se*. That over-specialization can cause a race to be unable to adapt itself to a change of

external conditions or environment, and thus lead to its extinction, will be admitted by everyone. But that a race can continue specializing in some particular direction beyond the point where the specialization is of use, and so far as to cause the actual extinction of the entire race, the environment remaining unchanged, appears to me utterly impossible. The moment the harmfulness of a character outbalanced its usefulness, a process of elimination must needs set in, weeding out the individuals in which the character was mostly highly developed. If such a thing as momentum in evolutionary progress exists, this process of elimination would act with more and more severity, in combating the action of momentum in evolving a character to a noxious degree, with each successive generation. I cannot believe that such a noxious character could be developed to the point of seriously reducing the expectation of life of the individuals in which it was present, much less of being the direct cause of the extinction of the race. Those who have advocated this, to me impossible, theory have repeatedly quoted *Smilodon* as an example in support.<sup>1</sup> In point of fact, as we have seen, the immense development of the canines in this animal made them highly efficient weapons for a particular mode of attack and was an essential element of its success in its especial mode of life, not a hindrance or bar to its survival. Whatever may be thought of the theory of "momentum in evolution," *Smilodon* cannot be used as an instance in its support.

*Geological and Geographical Distribution of the Felidæ.*

		FELINÆ	MACHÆRODONTINÆ
RECENT		<i>Felis</i> , E., N. A., S. A., As., Af.	
PLEISTOCENE	Upper	<i>Felis</i> , E., N. A., S. A., As. <i>Smilodon</i> , etc., N. A.	
	Lower	<i>Felis</i> , E., N. A., S. A., As. <i>Machærodus</i> , E., <i>Smilodon</i> , N. A., S. A.	
PLIOCENE	Upper	<i>Felis</i> , E., N. A., As.	<i>Machærodus</i> , E., As.
	Lower	<i>Felis</i> , E., As., ? N. A.	<i>Machærodus</i> , E, As.

<sup>1</sup> See Woodward, A. S., 1909, p. 326. Loomis, F. B., 1905, p. 840.

*Geological and Geographical Distribution of the Felidæ—Continued.*

		FELINÆ	MACHÆRODONTINÆ
MIOCENE	Upper	<i>Pseudælorus</i> , N. A.	<i>Machærodus</i> , E.
	Middle	<i>Pseudælorus</i> , E., N. A.	<i>Machærodus</i> , E.
	Lower	<i>Nimravus</i> , N. A.	
OLIGOCENE	Upper	<i>Dinictis</i> , <i>Nimravus</i> , N. A.	<i>Hoplophoneus</i> , N. A.
	U. Mid.	<i>Dinictis</i> , N. A.	<i>Hoplophoneus</i> , <i>Eusmilus</i> , N. A.
	L. Mid.	<i>Dinictis</i> , N. A.	<i>Hoplophonus</i> , N. A.
	Lower	<i>Dinictis</i> , N. A.; <i>Ælurictis</i> , E.	<i>Eusmilus</i> , E.
EOCENE		(Undiscovered Miacidæ) probably Asiatic	

## CLASSIFICATION AND SYNONYMY OF EXTINCT FELIDÆ.

Earlier writers, and especially Cope, used the presence or absence of the vestigial teeth in defining genera and species in this family, more than their importance or constancy warrants. The form, proportions and construction of the larger functional teeth, especially of the carnassials, appears to be much more constant, and later writers (Scott, Adams, Matthew, Merriam) have admitted the frequent variation in the vestigial teeth as mainly individual. Unless this be done the number of genera and species would be more than doubled.

*Felinæ.*

Carnassial notches deep; internal cusp of upper carnassial well developed, upper canines progressively reduced and lower canines progressively enlarged to the normal carnivore size and function. Forehead high, mastoid process progressively reduced, coronoid process of jaw enlarged and other progressive changes in skull and skeleton conditioned by reduction of upper canines. P<sup>3</sup> large, p<sub>3</sub> and p<sub>4</sub> subequal. Limbs elongate, feet compact, digitigrade, hallux progressively vestigial.

*Machærodontinæ.*

Carnassial notches shallow; internal cusp of upper carnassial vestigial; upper canines progressively enlarged and lower canines progressively reduced, incisiform.  $P^3$  small,  $P_3$  vestigial to absent. Occiput high, narrow,

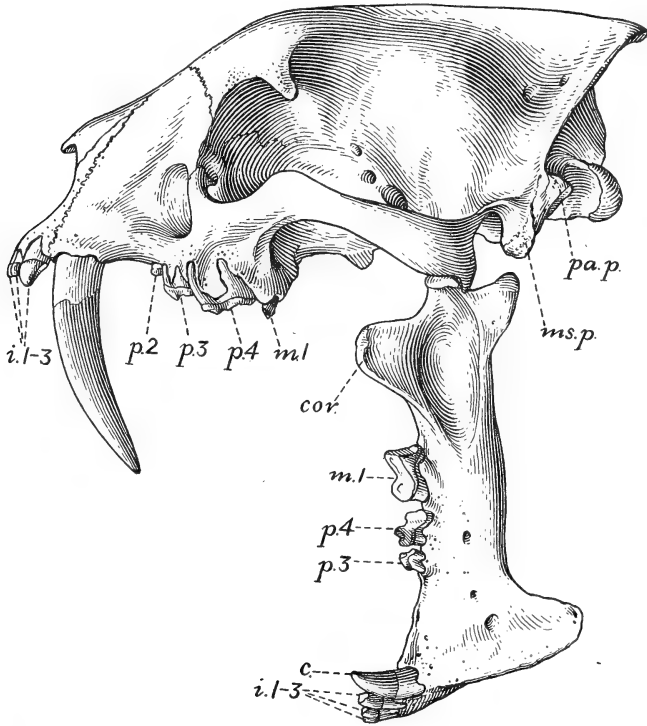


Fig. 10. *Dinictis squalidens*, skull and jaws, one half natural size. Am. Mus. No. 8777. Middle Oligocene; Oreodon Beds, White River, Colorado.

mastoid process prominent, progressively enlarged. Limbs robust, feet more spreading, hallux large, pollex larger than in *Felinæ*.

***Dinictis* Leidy, 1854.**

*Deinictis* LEIDY, 1854; *Dinictis* auct. plurim.

Syn., *Daptophilus* COPE, 1873.

Dentition normally  $I \frac{3}{3}$ ,  $C \frac{1}{1}$ ,  $P \frac{3}{3}$ ,  $M \frac{1}{2}$ , but vestigial  $p^1$  and  $m^2$  occasionally present,  $i_3$  ? occasionally absent.  $M_1$  with vestigial metaconid and distinct heel. Canines moderately long, symphyseal flange small.  $P^4$  with distinct protocone and no parastyle. Condylar and carotid foramina well separated from posterior lacerate foramen. Tympanic bulla incompletely ossified. Hallux well developed, functional.

This is a compact genus, the species all nearly related, except *D. cyclops* of the John Day, which is more sharply distinct.

*D. felina* Leidy, Oreodon Beds, White River, S. Dak. and Col. Typical and most abundant form.

*D. squalidens* (Cope). Oreodon Beds, White R., S. Dak. and Col. More slenderly proportioned, teeth less robust.

*D. paucidens* Riggs. White River, Wyoming, horizon unstated.

*D. fortis* Adams, ? Titanotherium Beds, White River, S. Dak.

*D. bombifrons* Adams, ? Leptauchenia Beds, White River, S. Dak.

*D. cyclops* Cope. John Day Beds, Oregon. Short face, convex forehead.

### Nimravus Cope, 1879.

Syn., *Ælurogale* Filhol non Fitzinger, *Ælurictis* Trouessart: *Archælorus* Cope, *Pogonodon* Cope. Dentition  $I \frac{3}{3} C \frac{1}{1} P \frac{4-3}{3-2} M \frac{1}{1-2}$ .  $M_1$  with distinct heel but no metaconid. Canines intermediate between *Dinictis* and *Felis* in proportions, symphysis angulate but flange very slight or none.

Other characters as in *Dinictis*.

This genus covers a much wider range of variation than *Dinictis*, but does not readily fall into subgenera. Several of the species from the John Day beds show a peculiar bony outgrowth beneath the lower carnassial, correlated with a precocious reduction of the upper and enlargement of the lower canines, and designed apparently to shift the support of the lower carnassial outwards in such a way as to afford space for a more powerful masseter attachment than the construction of the skull and jaws would otherwise admit. This constitutes a precocious adaptation functionally analogous to the widening of palate and jaws of the modern Felidæ.

*N. (Archælorus) debilis* Cope. Dentition  $\frac{3 \cdot 1 \cdot 4 - 3 \cdot 1}{3 \cdot 1 \cdot 3 \cdot 2}$ . Upper canines but little larger than the lower, symphysis without flange and slight angulation. Bony outgrowth beneath  $m_1$  very prominent. Size medium. John Day.

*N. gomphodus* Cope. Dentition  $\frac{3 \cdot 1 \cdot 3 \cdot 1}{3 \cdot 1 \cdot 2 \cdot 2}$ . Upper canines shorter than in *Dinictis*, nearly straight. Symphysis with marked angulation but no flange. Exostosis beneath  $m_1$  slight. Size medium. John Day.

*N. confertus* Cope. Only the lower jaw is known. Like the preceding species but smaller. John Day.

*N. brachyops* (Cope). Like *N. gomphodus* and doubtfully separable from it except by absence of the infracarnassial exostosis. John Day.

*N. (Pogonodon) platycopis* (Cope). Dentition  $\frac{3 \cdot 1 \cdot 3 \cdot 1}{3 \cdot 1 \cdot 3 \cdot 1}$ . Upper canines stout, moderately curved. Symphysis with marked angulation and slight flange. No exostosis beneath  $m_1$ . Size large, equalling the lion. John Day.

*N. sectator* Matthew, 1907. Dentition  $\frac{3 \cdot 1 \cdot 2 \cdot 1}{3 \cdot 1 \cdot 2 \cdot 1}$ . Symphysis with marked angulation but no flange. No exostosis beneath  $m_1$ . Size intermediate between *N. gomphodus* and *platycopis*. Lower Rosebud, S. Dakota.



*N. major* (Lucas 1898). From the size and stated characters of *Dinictis major* and its geological level, I suspect that it will prove on examination to be referable to *Nimravus* rather than *Dinictis*. Gering, Nebraska.

*N. (Ælurictis, Ælurogale) intermedia* (Filhol). Phosphorites, France.

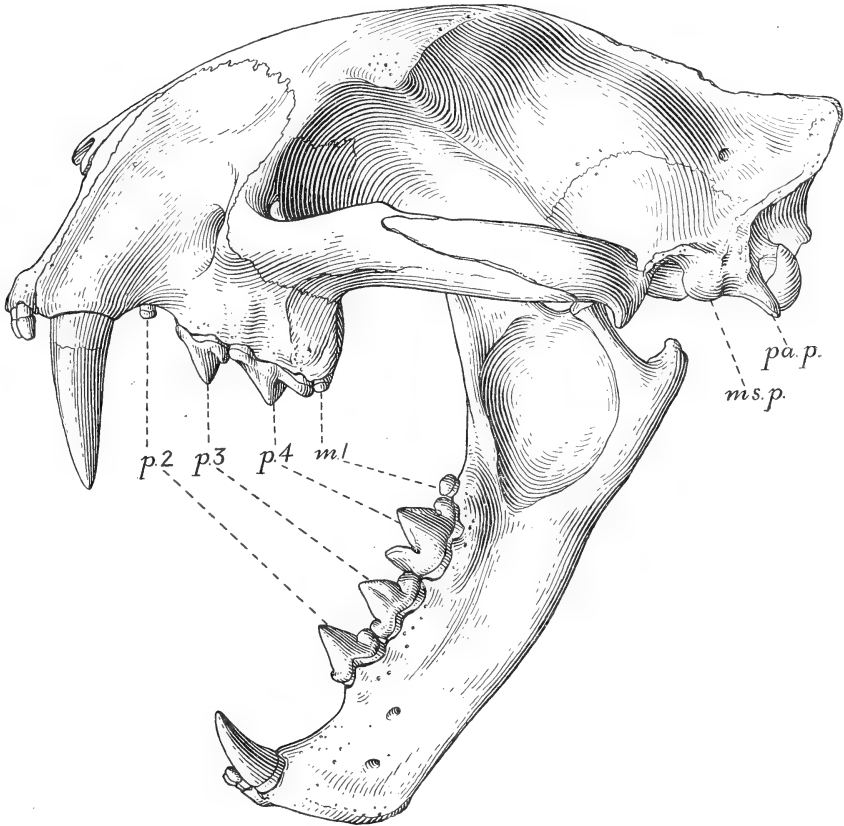


Fig. 11. *Nimravus gomphodus*, skull and jaws, one half natural size. Am. Mus. No. 6933. Upper Oligocene, John Day, Oregon.

*N. catocopsis* (Cope 1887). Size of lion. Known only from symphysis mandibuli, and generic position provisional. Lower Pliocene, Kansas.

### **Pseudælurus** Gervais, 1848-52.

Dentition  $I \frac{3}{3}$ ,  $C \frac{1}{1}$ ,  $P \frac{3}{3}$ ,  $M \frac{1}{1}$ . Lower sectorial with vestigial heel, no metaconid; upper sectorial with rudimentary parastyle. Canines normal. Symphysis without flange or noticeable angulation. Basicranial and skeletal characters unknown.

*P. quadridentatus* (Blainville). Middle Miocene (Sansan) France.

*P. intrepidus* Leidy, 1858. Known only from the lower jaw. Upper Miocene, Nebraska beds, Fort Niobrara, Neb. A lower jaw from the Middle Miocene Pawnee Creek beds of Colorado appears to be a primitive mutation of this species.

### **Felis s. l.**

Dentition  $I \frac{3}{3}$   $C \frac{1}{1}$   $P \frac{2-3}{2}$   $M \frac{1}{1}$ . Lower sectorial lacking both metaconid and heel, upper sectorial with well developed parastyle. Symphysis without flange or angle.

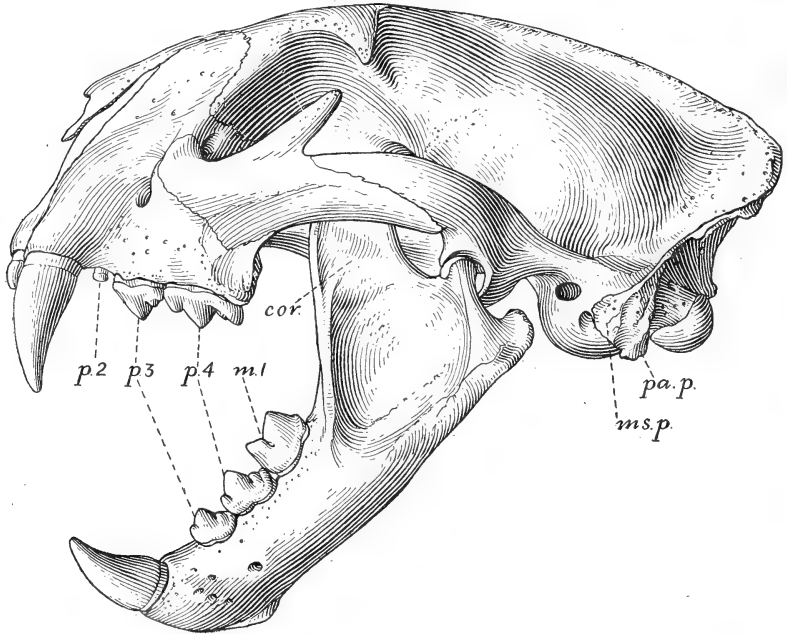


Fig. 12. *Felis concolor*, skull and jaws, one half natural size. Am. Mus. No. 11082. Recent.

Canines normal. Condylar and carotid foramina closely connected with foramen lacerum posterius, tympanic bulla completely ossified. Mastoid process vestigial; paroccipital process directed downwards, flattened and closely embracing the posterior surface of the tympanic bulla. Hallux vestigial.

### **Hoplophoneus Cope, 1874.**

Dentition  $I \frac{3}{3-2}$   $C \frac{1}{1}$   $P \frac{3-2}{2}$   $M \frac{1}{1}$ . Upper carnassial with rudimentary parastyle, lower carnassial with metaconid and heel vestigial.  $P^2$  vestigial,  $p_2$  normally absent,  $p \frac{3}{3}$  much reduced. Upper canines slender. Basicranial region as in *Dinictis*, bulla incompletely ossified. Hallux well developed.

This genus is represented by several distinct but rather closely allied species in the White River formation of Colorado and South Dakota.

*H. oreodontis* Cope. C-M<sup>1</sup> = 53 mm.

*H. primævus* (Leidy, 1851) C-M<sup>1</sup> = 60 mm. Canines long and slender, skull rather short, p<sup>2</sup> one-rooted.

*H. robustus* Adams 1896. C-M<sup>1</sup> = 70 mm. Canines stouter, skull longer, muzzle heavier, p<sup>2</sup> two-rooted.

*H. insolens* Adams 1896. C-M<sup>1</sup> = ? 75 mm.

*H. occidentalis* Leidy 1869. C-M<sup>1</sup> = 92 mm. Skull long and muzzle heavy.

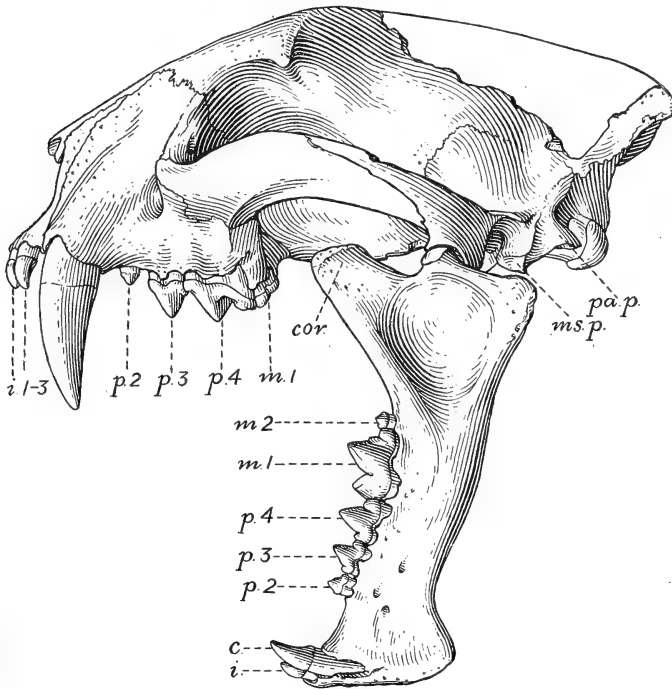


Fig. 13. *Hoplophoneus primævus*, skull and jaws, one half natural size. Am. Mus. No. 11858. Middle Oligocene, Oreodon Beds, White River, South Dakota.

"*Pogonodon*" *davisi* of the John Day appears from Merriam's figures to be referable to this genus and distinct from any of the *Dinictis* phylum.

### **Eusmilus** Gervais, 1876.

Dentition I<sub>2</sub> C<sub>1</sub> P<sub>1</sub> M<sub>1</sub>. Lower carnassial without heel or metaconid. Skull unknown. Symphyseal flange deep (= long and slender upper canine).

*E. bidentatus* (Filhol). Phosphorites, France.

*E. dakotensis* Hatcher. Upper Oligocene (Protoceras Beds) S. Dakota. Large species, size of lion?.

This genus is more progressive than *Hoplophoneus*, but apparently out of the direct line of descent.

**Machærodus** Kaup, 1833.

Dentition I  $\frac{3}{3}$  C  $\frac{1}{1}$  P  $\frac{2}{2-1}$  M  $\frac{1}{1}$ . Upper carnassial with well developed parastyle and

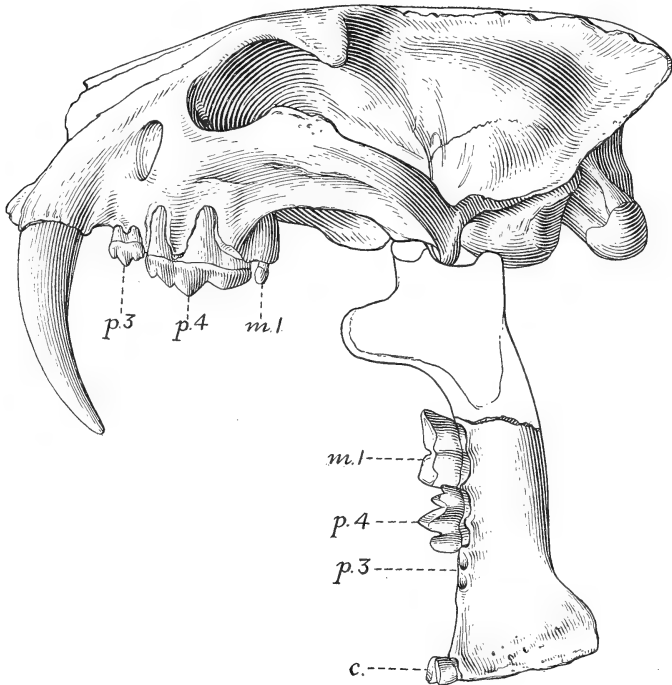


Fig. 14. *Machærodus palmidens*, skull and jaws, half natural size. Middle Miocene, Sansan, France. After Filhol [I suspect certain inaccuracies in this drawing, but do not venture to alter them].

sometimes a fourth external cusp anterior to it. Lower carnassial without heel or metaconid. P  $\frac{3}{3}$  vestigial. Canines stout, symphyseal flange deep. Bullæ completely ossified.

European and Asiatic, Miocene to Pleistocene. No recorded specimens from the American Tertiary can positively be referred to this genus.

**Smilodon** *Lund*, 1842.

Dentition  $I \frac{3}{3-2}$   $C \frac{1}{1}$   $P \frac{2}{2-1}$   $M \frac{1}{1}$ . Parastyle of upper carnassial large, fourth cusp variably developed. Lower carnassial without heel or metaconid. Canines large, stout, no symphyseal flange nor angle.  $P^3$  vestigial,  $p_3$  usually absent. Bulla com-

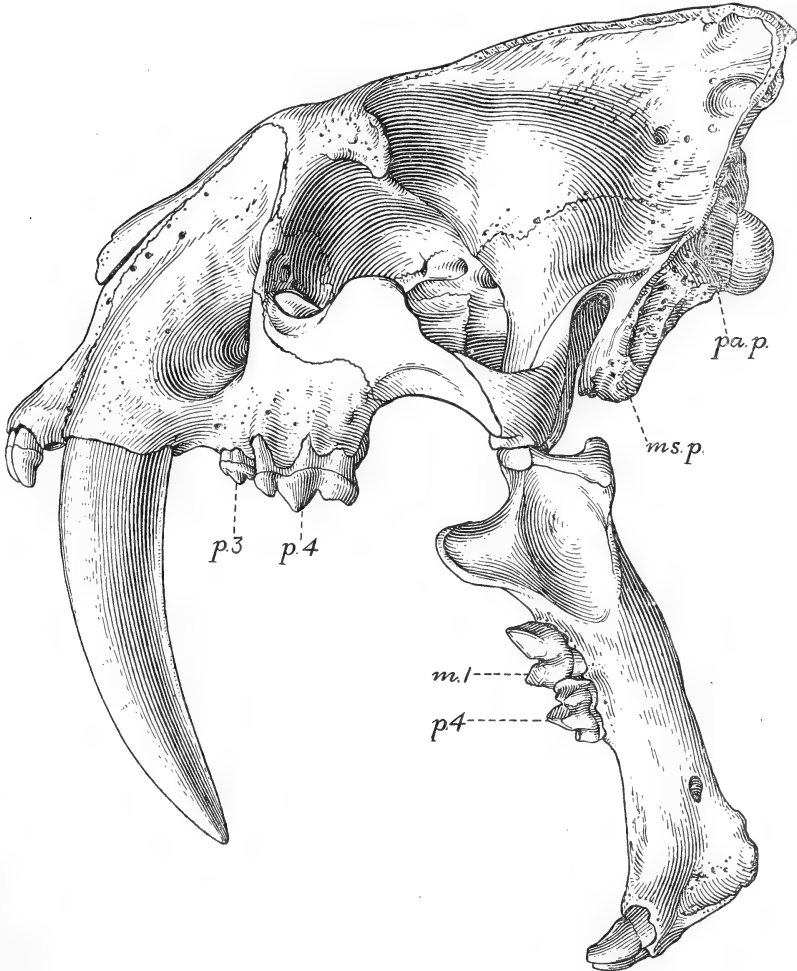


Fig. 15. *Smilodon californicus*, skull and jaws, one third natural size. Am. Mus. No. 14349. Pleistocene, California. (Exchange from Univ. Cal.)

pletely ossified, condylar foramen distinct, hallux well developed. Several subgenera, all from the New World, so far as records show. The type is from the Pleistocene of South America.

*Trucifelis* Leidy, 1868. Antero-external (fourth) cusp of P<sup>4</sup> large.

*Dinobastis* Cope, 1893. No internal root on p<sup>4</sup>.

*Smilodontopsis* Brown, 1908. Entepicondylar foramen present.

The later Machærodonts are much in need of revision.

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**Article XXVII. COLLATION OF BRISSON'S GENERA OF BIRDS  
WITH THOSE OF LINNÆUS.**

BY J. A. ALLEN.

CONTENTS.

	Page.
Introduction . . . . .	317
Brisson not greatly indebted to Linnæus . . . . .	319
Linnæus's indebtedness to Brisson . . . . .	320
Brisson's methods and resources . . . . .	320
Brisson's genera . . . . .	322
Brisson and Linnæus statistically compared . . . . .	324
Brisson's 'Ornithologia' compared with the Aves of the tenth edition of Lin- næus's 'Systema' . . . . .	325
Brisson's new genera and their Linnæan equivalents . . . . .	327
Brisson's new names for Linnæan genera . . . . .	330
Linnæan (1764 and 1766) new names for Brissonian genera . . . . .	330
Brissonian names adopted by Linnæus . . . . .	330
Brissonian names wrongly ascribed to other authors in Sharpe's 'Handlist of Birds' . . . . .	330
The relation of six Brissonian genera to Linnæan genera . . . . .	332
<i>Mergus</i> Linn. and <i>Merganser</i> Briss. . . . .	332
<i>Meleagris</i> Linn. and <i>Gallopavo</i> Briss. . . . .	332
<i>Alcedo</i> Linn. and <i>Ispida</i> Briss. . . . .	332
<i>Cotinga</i> Briss. and <i>Ampelis</i> Linn. . . . .	333
<i>Coracias</i> Linn. and <i>Galgulus</i> Briss. . . . .	333
<i>Tangara</i> Briss. and <i>Tanagra</i> Linn. . . . .	334

INTRODUCTION.

In considering recently certain questions of ornithological nomenclature it became necessary to examine the works of Brisson and Linnæus in considerable detail and this examination finally led to a careful collation of Brisson's 'Ornithologia,' published in 1760, with the sixth, tenth, and twelfth editions of Linnæus's 'Systema Naturæ,' published respectively in 1748, 1758, and 1766.

As every systematic ornithologist has had occasion to learn, Linnæus's treatment of the class Aves was based on very imperfect knowledge of the subject. As is well-known, this great systematist was primarily a botanist, secondarily a zoölogist, and only incidentally a mammalogist and ornithologist. Through isolation he was deprived of access to any of the collections of mammals and birds then extant in the larger cities of Europe, and

his acquaintance with the literature of these subjects was evidently exceedingly defective, at least at the time he prepared the sixth and tenth editions of his great systematic compendium of zoölogy. Yet this work, with all its shortcomings, is not only the basis of systematic nomenclature, but furnished a zoölogical classification that served for the time being to reduce "a chaos to a semblance of order," and became the foundation on which has since arisen the elaborate superstructure of modern zoölogy.

Brisson, on the other hand, was a specialist, his interest in zoölogy being mainly restricted to mammals and birds.<sup>1</sup> He had access in Paris to the largest collections of these animals then in existence, and to libraries that contained all the literature relating to them. It is thus not strange that in this restricted field, with all these advantages, he should have outstripped his great contemporary whose field was the whole realm of biology.

The zoölogical writings of Linnæus, excluding a few minor papers, comprise the 'Fauna Suecica,' in two editions (1746 and 1761), the 'Museum Adolphei Friderici' (Part I, 1754; Part II, 1764), the 'Museum Ludovicæ Ulricæ' (1764), and the several editions of the 'Systema Naturæ.' The zoölogy of the sixth edition of this work (1748) comprised only 76 octavo pages, and was in effect a synopsis of the fauna of Sweden, filled out, as regards the rest of the world, almost wholly by compilation from previous authors. In this edition the birds were arranged in six orders and 51 genera, comprising 260 species. In the tenth edition (1758) he retained the same six orders, but omitted some of the genera and added others, and rather more than doubled the number of species. In the twelfth (1766) the classification remained essentially the same as in the sixth, but some fifteen genera were added, and the number of species again nearly doubled. On comparison with the first edition it is found that some of the genera were transferred in the later editions from one order to another. In the sixth edition the Storm Petrel was placed with the Passerine birds, and as late as the twelfth edition the two species of Penguin known to him were still placed, the one in *Phaëthon* with the Tropic-bird, the other in *Diomedea* with the Albatross, and the Pratincole, a Limicoline bird, in the genus *Hirundo*. In the sixth edition of the 'Systema' birds occupied only 17 octavo pages; in the tenth the space allotted them was increased to 116 pages, and in the twelfth to 237 pages.

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<sup>1</sup> Mathurin Jacques Brisson (April 30, 1723–June 23, 1806), Member of the Academy and of the Institute, was for a time an enthusiastic zoölogist, but later turned his attention to physics, becoming professor of natural philosophy at the College of Navarre, and publishing in 1806 a 'Dictionnaire raisonné de physique.' He early projected a work on the Animal Kingdom ('Regnum Animale'), but published only the parts relating to mammals and birds, the first in 1756 and the second in 1760, when he was at the age, respectively, of 33 and 37 years.



## BRISSON NOT GREATLY INDEBTED TO LINNÆUS.

Brisson's great work,<sup>1</sup> in six quarto volumes, with over 4,000 pages of text and 261 plates, was published in 1760. It was two-thirds printed before he came in possession of the tenth edition of the 'Systema Naturæ,' published in 1758. He cited only the sixth edition throughout the first four volumes, and the tenth to the exclusion of the sixth in the last two. In the supplement to the sixth volume, in the addenda to the references in the main text of the work, he cites the tenth edition where it had been previously omitted, which is further evidence that this edition was not available to him till after the first four volumes of his own work were printed. It is impossible that a work of this magnitude could have all been printed within the space of a single year, or even in two years, at this early date. It is a work on which the author spent many years in its preparation; consequently it was practically completed and partly printed before the promulgation of binomial nomenclature for zoölogy.<sup>2</sup> Yet Brisson has been criticised for not employing the binomial system in his 'Ornithologia,' and for this reason objection has been made to the acceptance of his genera! He has also been charged with speaking slightly of Linnæus's classification, and for following a new system of his own invention. When, however, one recalls that the only edition of the 'Systema' Brisson knew of, in time to make use of it, was the sixth, his criticisms cannot be considered

<sup>1</sup> Ornithologia | sive | Synopsis Methodica | sistens Avium divisionem in Ordines, | Sectiones, Genera, Species, ipsarumque Varietates. | Cum accurata cujusque speciei | descriptione, citationibus auctorum de iis tractantium | nominibus eis ab ipsis & nationibus impositis, nomi- | nibusque vulgaribus. | A. D. Brisson, Regiæ Scientiarum Academiæ Socio. | Opus figuris æneis adornatum. | Volumen I [-VI]. [Design] Parisiis, | Ad Ripam Augustinoram, | Apud Cl. Joannem-Baptistam Bauche, Bibliopolam, | ad Insigne S<sup>te</sup>. Genovefæ, & S<sup>ti</sup>. Joannis in Deserto. — | M. DCC. LX. | Cum Approbatione, et Privilegio Regis.

[Or:] Ornithologie | ou | Méthode | contenant la Divisions des Oiseaux | en Ordres, Sections, Genres, Espèces & leurs Variétés. | A laquelle on a joint une Description | exacte de chaque espece, avec les citations des auteurs | qui en ont traité, les noms qu'ils leur ont donnés, ceux | que leur ont donnés les différentes nations, & les noms | vulgaires, | Par M. [Mathurin Jacques] Brisson, de l' Académie Royale des Sciences. | Ouvrage enrichi de figures en taille douce. | Tome I [-VI]. [Design] A Paris, | Quay des Augustins, | Chez Cl. Jean-Baptiste Bauche, Libraire, à l'Image Sainte | Geneviève & S. Jean dans le Désert. | — | M. DCC. LX. | Avec approbation, et privilege du Roi. — 6 vols. 4to.

Vol. I, pp. xxiv + 526 + lxxiv, 1 l., pll. i-xxxvii; Vol. II, 2 ll., pp. 516 + lxxviii, pll. i-xlvi; Vol. III, 2 ll., pp. 734 + xcii, pll. i-xxxvii; Vol. IV, 2 ll., pp. 576 + liv, 1 l., pll. i-xlvi; Vol. V, 2 ll., pp. 544 + lvi, pll. i-xlii; Vol. VI, 2 ll., pp. 542 + lxxvi, 1 l., pp. 146 + xxii, 1 l., pl. i-xlvi + i-vi: = 12 unpag'd leaves, 3,584 pp. text, 456 pp. indexes, 261 plates. Text in Latin and French, in parallel columns.

<sup>2</sup> At the end of the first volume of the work are given extracts from the registers of the Paris Royal Academy of Sciences, to the effect that on August 9, 1758, M<sup>rs</sup>. Duhamel and de Jussieu, having been appointed to examine Brisson's work, "l'Ornithologie ou le troisième Classe du Regne Animal," reported that it was a work of unusual merit, and on April 1, 1759, the Academy authorized its being printed with the "approbation de l'Académie." The copyright, under the order of the King, however, is dated "5 Juin 1750."

as without warrant; nor can he be charged with refusing to accept binomial nomenclature when his work was practically completed and partly printed before the binomial system for zoölogy was really in existence.

Brisson knew the birds of the world as no other man of his time knew them, and more thoroughly than any other one man knew them for generations after him. He broke up the incongruous Linnæan combinations of genera into orders and sections, and the incongruous associations of species into additional genera, in many cases closely approximating the group boundaries, especially as regards many of his orders, of modern classifications. Through the recognition of 26 orders in place of the Linnæan 6, and of 115 genera in place of the 51 of Linnæus's sixth edition, or the 63 of his tenth edition, Brisson was able to approximate a much more natural classification of both genera and species. He knew personally from specimens he had actually had in hand over 800 species, through which knowledge he was able the better to correlate those he had not seen and knew only from figures or descriptions. It is thus evident that his indebtedness to Linnæus as a source of information was extremely slight.

#### LINNÆUS'S INDEBTEDNESS TO BRISSON.

As already shown, the publication of Linnæus's tenth edition, although of two year's earlier date than Brisson's own work, was too late to be of much real service to Brisson. While the 'Ornithologia' of Brisson appeared too late to be of use to Linnæus in the preparation of his tenth edition, it was of very great use to him in the preparation of his twelfth edition. Of the 386 species added in the twelfth, 240 are based exclusively on Brisson, and a large part of the others on Brisson and his citations of authors not previously utilized by Linnæus. Of the 15 genera added by Linnæus in his twelfth edition, 14 were taken from Brisson. He did not, however, adopt all of Brisson's genera, nor nearly all of his species, though most of the latter eventually received binomial names at the hands of other compilers. Linnæus was thus the first author to give nomenclatural status to a large number of Brisson's species, but in adopting Brisson's generic groups he renamed most of them.

#### BRISSON'S METHODS AND RESOURCES.

A few excerpts from Brisson's preface will show his viewpoint, methods, and resources. In the first place, as to his resources: He had access, as curator, to the magnificent collection of birds, for that time, of his friend

M. René Antoine Ferchault de Réaumur, the celebrated physicist and naturalist, to which collection accessions were constantly being made from all parts of the world, through Réaumur's numerous and zealous correspondents, during the preparation of Brisson's work. For this reason its publication, the author tells us, was not only considerably delayed in order to insert the many new species thus discovered, but resulted in the addition of others in a final supplement.

His concise résumé of the works of previous authors gives his own point of view. After reference to Belon, the first author, he says, to give some order to this part of natural history, and to Gesner, Aldrovandus, Schwenckfeld, Jonston, Willughby, Ray, and Barrere, he comes to Linnæus's '*Systema Naturæ*.' Of this work he observes that the characters given are insufficient not only for comprehending the species which were new, but also those he has given for the genera, since many of the species placed under them have not the characters indicated for the genus: a just criticism, as known to all users of the '*Systema*.'

After further reference to the literature of the subject, including the works of Mœhring, Klein, and other systematists, and the contributions of others besides the great "historians and systematists," as Hernandez, Marcgrave, Frisch, Albin, Catesby, and Edwards, he goes on to explain his own classification and his methods of procedure. His higher groups, termed orders and sections, are designated merely by numbers, under which are arranged the genera, species and varieties. He says of his plan of classification that he divides the birds into 26 orders, which contain 115 genera, and about 1,500 species and varieties.<sup>1</sup>

The primary divisions, or orders, are based on the characters furnished by the feet and bill, other characters being the number and position of the toes, and their membranes, whether present or absent, and their character when present. The subdivisions of the orders, or the "sections," are founded on the form of the bill, while other particulars determine the genera; and, finally, differences in color distinguish the species.

Regarding his descriptions of the species he says, in effect: "All the birds which I have seen are described with the most scrupulous exactitude. With regard to the others, which are the smaller number, I have been obliged to take them from the authors who have described them. I have only rendered their descriptions analogous to mine, following the same plan for all, to render it easier to compare, in all cases, one species with another, in order to see precisely how they differ. One can thus surely depend upon the descriptions which I have made with the animal under my eyes. As

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<sup>1</sup> The species number 1,336, with about 150 additional "varieties."

guaranty for the exactitude of the descriptions of the other species I cite the authors on which they are based; and in order to distinguish the one from the other, I have marked with two stars the species I have described from the animal itself, and with one star those of which I have seen only some parts. The rest of the description and the entire descriptions of species not thus marked are based on the different authors cited in this work;<sup>1</sup> and I always prefer to follow those who have seen the animal."

Thus one knows, when using Brisson's work, what species were personally known to him and described directly from specimens, and what species are based on the works of previous authors — a point of great interest and value to his successors. We thus have in Brisson's work descriptions which, while to some extent burdened with non-essentials, are among the most detailed and exact in descriptive ornithology. These are supplemented by more than two hundred and sixty uncolored plates, which in artistic execution and exactness of detail far excel any that preceded them, and are still good standards of reference.

He continues: "At the end of each description I indicate the country where the bird described is found: and, for proof that I have advanced nothing that is not certain, I state, at least with regard to the species that form the cabinet of the late M. Réaumur, who the correspondent is who has been willing to take the trouble to collect and send them to him."

#### BRISSON'S GENERA.

All this, and much more that might be taken from Brisson's preface, shows an exact and painstaking author whose devotion to accuracy and appreciation of essential details was rare in his day and generation and is still worthy of emulation. In fact, the superior excellence of Brisson's ornithological work was so apparent as to impress upon the British Association Committee on Zoölogical Nomenclature in 1842, the desirability of conserving Brisson's genera by a special provision when that Committee unwisely adopted the twelfth edition of Linnæus's '*Systema Naturæ*,' instead of the tenth, as the starting-point of the binomial system of nomenclature. Under present codes of nomenclature no such special provision is necessary, since binomial nomenclature, according to all zoölogical codes, begins at 1758. Brisson's nomenclature conforms to Art. 25 of the International Code of Zoölogical Nomenclature, in being binary although not binominal; his generic names meet all the requirements of this Article

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<sup>1</sup> His bibliography at the end of the preface numbers about seventy titles, and includes all of the principal ornithological works of previous authors.

and are available; his specific names are not available, since they are binominal only exceptionally and by chance.

It is of interest in this connection to note the opinion held by so high an authority as the late Alfred Newton (*Dictionary of Birds*, Introduction, pp. 9, 10, 1896) of Brisson's 'Ornithologie,' who says of it: "... a work of very great merit so far as it goes, for as a descriptive ornithologist the author stands even now unsurpassed.... His attempt at classification was certainly better than that of Linnæus; and it is rather curious that the researches of the latest ornithologists point to results in some degree comparable with Brisson's systematic arrangement,.... But greater value lies in his generic or subgeneric divisions, which taken as a whole, are far more natural than those of Linnæus, and consequently capable of better diagnosis. More than this, he seems to be the earliest ornithologist, perhaps the earliest zoölogist, to conceive the idea of each genus possessing what is now called a 'type' — though such a term does not occur in his work; and, in like manner, without declaring it in so many words, he indicated unmistakably the existence of subgenera — all this being effected by the skilful use of names. Unfortunately he was too soon in the field to avail himself, even had he been so minded, of the convenient mode of nomenclature brought into use by Linnæus.... It is certain that the first four volumes were written if not printed before that method was promulgated, and when the fame of Linnæus as a zoölogist rested on little more than the very meagre sixth edition of the *Systema Naturæ* and the first edition of his *Fauna Suecica*."

As already said, Brisson divided the class Aves into 115 genera, or 52 more than Linnæus recognized in 1758. Both Brisson and Linnæus took a large part of their generic names from earlier authors, as Gesner, Ray, and Moehring. Of the 51 genera employed by Linnæus in his sixth edition (the last known to Brisson until his work was two thirds printed) 33, or 65 per cent, are used by Brisson; of the 63 used by Linnæus in the tenth edition 36, or 56 per cent, are found in Brisson, although neither apparently adopted names from the other, but took them from an earlier common source. In the case of the twelfth edition, however, the case is different, since Linnæus obviously took most of his new genera from Brisson, in part retaining Brisson's names for them but in most cases giving them new names.

Taking Linnæus's sixth edition as the only proper starting point in this collation, it is to be noticed that where Brisson separated Linnæus's incongruous generic groups into two, three, or more genera he often, but not always, retained the name of the original group for one of its subdivisions. In other cases he gave new names to all the subdivisions and did not retain the original name for any of them, as in the case of *Falco*, *Tetrao*,

*Trochilus*, *Fringilla*, etc., or employed them in a wholly different sense, as is shown in detail in the following analyses and comparative tables.

# BRISSON AND LINNÆUS STATISTICALLY COMPARED.

Orders.		Genera.	
1748.	Linnæus, 6th ed., 6	1748.	Linnæus, 6th ed., 51
1758.	" 10th " 6	1758.	" 10th " 63
1760.	Brisson, Orn., 26	1760.	Brisson, Orn., 115
1766.	Linnæus, 12th ed., 6	1766.	Linnæus, 12th ed., 78

Species.	
1748.	Linnæus, 6th ed., 260
1758.	" 10th " 545
1760.	Brisson, Orn., 1,386
1766.	Linnæus, 12th ed., 931

From the above it will be seen that the number of genera recognized by Brisson is not only more than twice the number given in Linnæus's sixth edition, but the number of species is five times greater, the increase in the number of genera being due not so much to the breaking up of the Linnæan genera into smaller groups as to the inclusion of many forms of bird life unknown to Linnæus when he prepared not only the sixth, but even the tenth, edition of the 'Systema.'

It is of interest to note also the steady increase in the number of species in certain well-defined groups from 1748 to 1766, as represented in the sixth, tenth, and twelfth editions of the 'Systema' of Linnæus and in Brisson's work, as shown in the subjoined table. Most of the species added in the twelfth edition are based exclusively on Brisson, but Linnæus appears to have been too conservative to accept all the species recognized by Brisson.

Genus <i>Columba</i> .		Genus <i>Falco</i> (= <i>Accipiter</i> + <i>Aquila</i> Briss.).	
1748.	Linnæus, 6th ed., 4 species.	1748.	Linnæus, 6th ed., 15 species.
1758.	" 10th " 22 "	1758.	" 10th " 26 "
1760.	Brisson, Orn., 44 "	1760.	Brisson, Orn., 51 "
1766.	Linnæus, 12th ed., 40 "	1766.	Linnæus, 12th ed., 32 "

Genus <i>Vultur</i> . <sup>1</sup>		Genus <i>Strix</i> (= <i>Asio</i> + <i>Strix</i> Briss.).	
1748.	Linnæus, 6th ed., 0 species.	1748.	Linnæus, 6th ed., 10 species.
1758.	" 10th " 6 "	1758.	" 10th " 11 "
1760.	Brisson, Orn., 12 "	1760.	Brisson, Orn., 20 "
1766.	Linnæus, 12th ed., 8 "	1766.	Linnæus, 12th ed., 12 "

<sup>1</sup> The genus *Vultur* was established by both Linnæus and Brisson, quite independently of each other—by Linnæus in 1758, by Brisson in 1760. The same is also true of the genus *Emberiza*.

Genus *Caprimulgus*.

1748.	Linnæus, 6th ed.,	0 species.
1758.	" 10th "	2 "
1760.	Brisson, Orn.,	7 "
1766.	Linnæus, 12th ed.,	2 "

Genus *Hirundo*.

1748.	Linnæus, 6th ed.,	5 species.
1758.	" 10th "	8 "
1760.	Brisson, Orn.,	17 "
1766.	Linnæus, 12th ed.,	12 "

Genus *Picus*.

1748.	Linnæus, 6th ed.,	11 species.
1758.	" 10th "	13 "
1760.	Brisson, Orn.,	32 "
1766.	Linnæus, 12th ed.,	21 "

Genus *Trochilus* (= *Polytmus*  
+ *Mellisuga* Briss.).

1748.	Linnæus, 6th ed.,	3 species.
1758.	" 10th "	18 "
1760.	Brisson, Orn.,	36 "
1766.	Linnæus, 12th ed.,	22 "

Genus *Cuculus*.

1748.	Linnæus, 6th ed.,	1 species.
1758.	" 10th "	8 "
1760.	Brisson, Orn.,	28 "
1766.	Linnæus, 12th ed.,	22 "

Genus *Ramphastos* (= *Tucana* Briss.).

1748.	Linnæus, 6th ed.,	4 species.
1758.	" 10th "	4 "
1760.	Brisson, Orn.,	12 "
1766.	Linnæus, 12th ed.,	8 "

Genus *Anas* (= *Anas* + *Anser* Briss.).

1748.	Linnæus, 6th ed.,	25 species.
1758.	" 10th "	39 "
1760.	Brisson, Orn.,	58 "
1766.	Linnæus, 12th ed.,	45 "

BRISSON'S 'ORNITHOLOGIA' COMPARED WITH THE AVES OF THE TENTH  
EDITION OF LINNÆUS'S 'SYSTEMA.'

Although Linnæus's tenth edition was published in 1758 and Brisson's work in 1760, the two works were so nearly contemporaneous in preparation that, as already shown, neither author could have profited much from the labors of the other, except that Brisson in the supplement to his last volume adds about twelve species included in Linnæus's tenth edition on the double basis of Linnæus and Edwards, and about twenty on the basis of Edwards alone (mainly from Part II of the Gleanings, 1760).

Brisson's new generic groups number 64, all of which, except one based on a fictitious species, are now in current use. His new generic names number 80, 16 of which are new names for Linnæan genera. Of Brisson's new generic groups, 14 were adopted in essentially the same sense by Linnæus in his twelfth edition, he retaining Brisson's names for 4 of them and renaming 10 of them, while he ignored the other 50. Many of Brisson's generic names, however, have been erroneously accredited to Linnæus at 1766, even by writers who admit the availability of Brissonian names. On the other hand, many writers, taking the twelfth edition of Linnæus as the

starting point for binomial nomenclature, have credited Brisson with many of the Linnæan genera of the tenth edition.<sup>1</sup>

The chief factor operative in bringing discredit upon Brissonian genera is the attribution to him of a large number of names he never used in a generic sense. His genera are clearly defined by a diagnosis; preceding the account of each species is a Latin diagnosis of the species, in each case beginning with the name of the genus under which the species is described, which is the first word of the diagnosis. One of the species, usually the first, bears the same technical name as the genus, while the French vernacular name which introduces the species gives it as *the* species of the genus. For example, under the genus *Phasianus*, the first species is "1. Le Faisan," and the Latin species name is simply "*Phasianus*" = [*Phasianus*] *phasianus*. Under modern rules, such species are the tautonymic types of their respective genera. In the index at the close of each volume the genera and species are listed in the order of their occurrence in the volume, the genera being given as captions to the lists of species and serially numbered with Roman numerals, while the species are serially numbered with Arabic numerals. In this way the groups recognized by Brisson as genera are still further distinctly designated as such.

In the case of large genera, the species are *apparently* arranged in groups, which have been freely interpreted by many subsequent writers as employed by Brisson to indicate sections or subgenera; such names have often been used later as names of genera and attributed to Brisson as though he had used them in a generic sense. That this is an error of conception on the part of later writers is evident on inspecting a large genus like *Columba*, where part of the species names begin with *Columba*, part with *Ænas*, part with *Turtur*, and part with *Palumbus*; but the species names beginning with these words are not segregated but are scattered irregularly throughout the genus. They correspond to the vernacular designations *pigeon*, *turtle dove*, etc., as shown by the accompanying French vernacular names, which are merely given a Latin rendering, the text being in both Latin and French, in parallel columns. In the same way, under *Perdix*, we have *Perdix*, *Francolinus*, and *Coturnix* as the first word of the Latin species name, with their French equivalents; but here the species bearing these names stand together in groups. In the same way, *Pavo* and *Crax* occur under *Phasianus*; *Ara*, *Cacatua*, *Lorius* and *Psittacula* under *Psittacus*; *Passerculus*, *Linaria*, *Cardinalis*, *Vidua*, *Fringilla*, *Serinus*, and *Chloris* under *Passer*; *Merula*, *Mainatus*, *Oriolus*, and *Mimus* under *Turdus*;

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<sup>1</sup> Waterhouse, in his 'Index Generum Avium' (1889), credited 23 Linnæan genera to Brisson; why he was so inconsistent as not to credit all the Linnæan genera of 1758 to Brisson is not apparent.



and so on with the rest of the larger genera. We have here the original source of many familiar generic names of birds.<sup>1</sup>

In other cases names of this character are repeated under several different genera, as *Cardinalis* under *Tangara*, *Carduelis*, and *Passer*, etc. It is thus evident, from every correct point of view, that they were not intended as names of groups in any taxonomic sense,—in other words, as subgenera, as many writers have assumed. When such names are thrown out as having no technical status, and only the names used by Brisson as names of genera are considered, no fault can be reasonably found with Brisson's genera. They are almost without exception far more natural groups than those recognized as genera by Linnæus, the only contemporary author with whose genera Brisson's can be compared.

Brisson's genera of birds, when additional to those of the tenth edition of the 'Systema Naturæ,' have, in most cases, been accepted by subsequent ornithologists,<sup>2</sup> to the exclusion, in some cases but not in all, of names proposed later for the same groups by Linnæus (1764, 1766). Those additional to the twelfth edition have had almost universal recognition. As, however, there are exceptions to all general rules, an eminent and most excellent ornithologist, Dr. Ernst Hartert, has recently declared that he cannot accept Brisson's genera, since in his opinion they are not genera at all and have no claim to be treated as such; he consequently, in using Brisson's names of genera in his 'Die Vögel der paläarktischen Fauna' and elsewhere, uniformly attributes them to some later author, with or without the statement "ex Brisson." That Brisson's genera, *i. e.*, the groups he himself recognized as genera, are properly "defined" has above been shown.

#### BRISSON'S NEW GENERA AND THEIR LINNÆAN EQUIVALENTS.

Brisson's 65 new genera are based in part (17 of them) on species unknown to Linnæus in 1758, but the greater number (48) are formed by separating the constituents of the Linnæan genera into two or more generic groups, as shown by the following summary:

<sup>1</sup> Waterhouse (*Index Generum Avium*, 1889) has credited 23 of these generic names to Brisson, while Gray, fifty years earlier (*A List of the Genera of Birds*, 1840-1855), accredited most of these and many others to Brisson, which, while now in current use, date only from the authors who first properly employed them for names of either genera or subgenera.

<sup>2</sup> The British Association Code of Nomenclature of 1842, makes an exception in favor of the recognition of Brisson's genera, although published prior to 1766, the date adopted in the Code for the beginning of binomial nomenclature. Thus, under § 2, it is said: "It should be here explained, that Brisson, who was a contemporary of Linnæus and acquainted with the 'Systema Naturæ,' defined and published certain genera of birds which are additional [and likewise prior] to those in the 12th edition of Linnæus's work, and which are therefore of perfectly good authority."

*Gallus* Briss. = *Phasianus* Linn., part.

*Meleagris* Briss. = *Phasianus* Linn., part. = (*Numida*<sup>1</sup> Linn., 1764. Not *Meleagris*<sup>1</sup> Linn., 1758.)

*Lagopus* Briss. }  
*Perdix* Briss. } = *Tetrao* Linn.

*Accipiter* Briss. }  
*Aquila* Briss. } = *Falco* Linn.

*Asio* Briss. = *Strix* Linn. part.

*Coracia* Briss. = *Corvus* Linn. part. Not *Coracias* Linn. 1758 = *Graculus* Koch, 1816, non *Gracula* Linn. 1758.

*Pica* Briss. = *Corvus* Linn. part = *Pica* Linn. 1748, abandoned in his later editions.

*Garrulus* Briss. = *Corvus* Linn. part.

*Nucifraga* Briss. = *Corvus* Linn. part. The Linnæan genus *Corvus*, 1758 = 5 genera of Brisson, 1760.

*Galgulus* Briss. = *Coracias* Linn. part.

*Icterus* Briss. = *Coracias* Linn. 1758, part; nearly = *Oriolus* Linn. 1766.

*Cotinga* Briss. = *Lanius* Linn. part; nearly = *Ampelis* Linn. 1766.

*Muscicapa* Briss. = *Motacilla* Linn. part; = *Muscicapa* Linn. 1766. Almost universally wrongly attributed to Linn. 1766.

*Buphagus* Briss. Not in Linn. 1758; = *Buphaga* Linn. 1766. Both are monotypic with the same type, and the genus should be credited to Brisson.

*Promerops* Briss. = *Upupa* Linn. part.

*Tangara* Briss. Not in Linn. 1758; almost exactly equals *Tanagra* Linn. 1766, of which *Tanagra* is an emendation, both names being based on the Brazilian word *tangara*. Not so nearly = *Tanagra* Linn. 1764. (See below, p. 334.)

*Carduelis* Briss. }  
*Passer* Briss. } = *Fringilla* Linn., nearly.

*Coccothraustes* Briss. = *Loxia* Linn. part.

*Pyrrhula* Briss. = *Loxia* Linn. part. *Loxia* Linn. 1758 was divided by Brisson into three genera, and the name *Loxia* restricted to the single species *L. curvirostra* Linn.

*Colius* Briss. Not in Linn. 1758; = *Loxia* Linn. part 1766.

*Polytmus* Briss. }  
*Mellisuga* Briss. } = *Trochilus* Linn.

*Galbula* Briss. Not in Linn. 1758; = *Alcedo* Linn. part, 1766.

*Bucco* Briss. Not in Linn. 1758; = *Bucco* Linn. 1766.

*Trogon* Briss. Not in Linn. 1758; = *Trogon* Linn. 1766.

*Rupicola* Briss. Not in Linn. 1758; = *Pipra* Linn. 1766, part.

*Manacus* Briss. = *Parus* Linn. part; *Pipra* Linn. 1766, part.

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<sup>1</sup> = "*Gallina* Linn." in Hasselquist's '*Iter Palæstinum*,' 1757; its later republication in Hasselquist's '*Reise nach Palæstina*' in 1762 does not give it tenability, as Linnæus rejected it in 1758, in the tenth edition of his *Systema Naturæ*. "*Monedula* Linn. in Hasselquist," is perfectly parallel with *Gallina*. (Cf. Richmond, Proc. U. S. Nat. Mus., XXIV, pp. 684, 697.)

- Momotus* Briss. } = *Alcedo* Linn.  
*Ispida* Briss. }  
*Todus* Briss. Not in Linn. 1758; = *Todus* Linn. 1766.  
*Rhea* Briss. }  
*Casuarius* Briss. } = *Struthio* Linn. 1758, part. *Raphus* = *Didus* Linn. 1766, both  
*Raphus* Briss. } being monotypic with the same type. Brisson divided *Struthio*  
Linn. into 4 genera; *Raphus* should be adopted in place of  
*Didus*.  
*Himantopus* Briss. }  
*Pluvialis* Briss. } = *Charadrius* Linn. part.  
*Vanellus* Briss. }  
*Arenaria* Briss. } = *Tringa* Linn. part. Brisson divided *Tringa* into 5 genera,  
*Glareola* Briss. } all now current.  
*Phalaropus* Briss. }  
*Jacana* Briss. Not in Linn. 1758; = *Parra* Linn. 1766.  
*Limosa* Briss. }  
*Numenius* Briss. } = *Scolopax* Linn. part. Brisson made 3 genera of *Scolopax* Linn.,  
all still current.  
*Scopus* Briss. Not in Linn. 1758; = *Scopus* Gmelin, 1788, to whom the name is  
still often wrongly attributed; both are monotypic with the  
same type.  
*Cochlearius* Briss. Not in Linn. 1758; = *Cancroma* Linn. 1766; the latter is still  
in use by most writers.  
*Ciconia* Briss. }  
*Balearica* Briss. } = *Ardea* Linn. part.  
*Cariama* Briss. Not in Linn. 1758; = *Palamedea* Linn. 1766, part.  
*Anhima* Briss. Not in Linn. 1758; = *Palamedea* Linn. 1766, part, which name is  
still used erroneously in place of *Anhima*. *Palamedea* Linn.  
1766 = *Anhima* + *Cariama* Brisson, 1760.  
*Porphyrio* Briss. }  
*Gallinula* Briss. } = *Fulica* Linn. part.  
*Uria* Briss. Not in Linn. 1758; = *Colymbus* Linn. part, 1766.  
*Fratercula* Briss. = *Alca* Linn. part.  
*Spheniscus* Briss. = *Diomedea* Linn. part.  
*Catarractes* Briss. = *Phaëthon* Linn. part.  
*Mergus* Briss. (non Linn. 1758) = *Colymbus* Linn. part.  
*Puffinus* Briss. Not in Linn. 1758; = *Procellaria* Linn. part, 1766.  
*Stercorarius* Briss. = *Larus* Linn. part.  
*Anser* Briss. = *Anas* Linn. part.  
*Anhinga* Briss. Not in Linn. 1758 = *Plotus* Linn. 1766.  
*Sula* Briss. }  
*Phalacrocorax* Briss. } = *Pelecanus* Linn. part.  
*Corrira* Briss. = avis fict.

## BRISSON'S NEW NAMES FOR LINNÆAN GENERA.

Several of these names were used by Linnæus in his sixth edition but abandoned in the tenth; the others are names used by Mœhring in 1752, or by still earlier authors. Only in the case of the last eight of these names could Brisson have consciously departed from the names adopted by Linnæus in his tenth edition. The case is different with the next list of names, where Linnæus knowingly gave new names to ten of Brisson's genera.

*Gallopavo* Briss. = *Meleagris* Linn.  
*Manucodiata* Briss. = *Paradisea* Linn.  
*Ficedula* Briss. = *Motacilla* Linn.  
*Torquilla* Briss. = *Jynx* Linn.  
*Tucana* Briss. = *Ramphastos* Linn.  
*Apiaster* Briss. = *Merops* Linn.  
*Hydrocorax* Briss. = *Buceros* Linn.  
 with additional species.

*Ostralega* Briss. = *Hæmatopus* Linn.  
*Platea* Briss. = *Platalea* Linn.  
*Albatrus* Briss. = *Diomedea* Linn.  
*Ryghopsalia* Briss. = *Rynchops* Linn.  
*Merganser* Briss. = *Mergus* Linn.  
*Lepturus* Briss. = *Phaëthon* Linn.  
*Onocratulus* Briss. = *Pelecanus* Linn.  
*Avocetta* Briss. = *Recurvirostra* Linn.

## LINNÆAN (1764 AND 1766) NEW NAMES FOR BRISSONIAN GENERA.

*Buphaga* = *Buphagus* Briss.  
 (emendation).  
*Oriolus* = *Icterus* Briss. (nearly).  
*Plotus* = *Anhinga* Briss.  
*Parra* = *Jacana* Briss.  
*Cancroma* = *Cochlearius* Briss.

*Didus* = *Raphus* Briss.  
*Numida*<sup>1</sup> = *Meleagris* Briss. non Linn.  
*Pipra*<sup>1</sup> = *Manacus* Briss. (nearly).  
*Ampelis* = *Cotinga* Briss. (nearly).  
*Tanagra*<sup>1</sup> = *Tangara* Briss. (emendation?).

## BRISSONIAN NAMES ADOPTED BY LINNÆUS.

*Muscicapa.*  
*Bucco.*

*Trogon.*  
*Todus.*

Perhaps *Buphagus* (adopted by Linnæus as *Buphaga*) should be added to this list, making 5 Brissonian generic names adopted by Linnæus.

BRISSONIAN NAMES WRONGLY ASCRIBED TO OTHER AUTHORS IN SHARPE'S  
'HANDLIST OF BIRDS.'

Sharpe's 'Handlist of Birds' (1899-1909) may be taken as representing general usage at the time when the several volumes were published, in respect to Brissonian genera wrongly ascribed to other authors, and also in respect to genera wrongly ascribed to Brisson.

<sup>1</sup> These date from 1764.

Of Brisson's 64 new genera, 58 are tenable,<sup>1</sup> and most of them have long been in nearly universal use. The 47 recognized as Brissonian in the 'Handlist,' in the order of sequence in Brisson's work, are the following:

Gallus	Carduelis	Hydrocorax	Porphyrio
Lagopus	Passer	Casuarius	Gallinula
Perdix	Coccothraustes	Himantopus	Uria
Accipiter	Colius	Vanellus	Fratercula
Aquila	Pyrrhula	Arenaria	Spheniscus
Asio	Polytmus	Glareola	Catarractes
Pica	Mellisuga	Phalaropus	Puffinus
Garrulus	Galbula	Limosa	Stercorarius
Nucifraga	Bucco	Numenius	Anser
Icterus	Rupicola	Ciconia	Sula
Cotinga	Manacus	Balearica	Phalacrocorax
Promerops	Momotus	Cariama	

The following 7 Brissonian genera are wrongly attributed by Sharpe (in common with most other authors) to Linnæus at 1766, or to some still later author:

<i>Muscicapa</i> to Linnæus,	<i>Jacana</i> to Schæffer,
<i>Buphagus</i> to Linnæus (as <i>Buphaga</i> ),	<i>Scopus</i> to Gmelin,
<i>Todus</i> to Linnæus,	<i>Rhea</i> to Latham.
<i>Trogon</i> to Linnæus,	

The following 5 Brissonian genera have priority over those commonly in use for the same groups:

<i>Raphus</i> should replace <i>Didus</i> Linn.
<i>Anhinga</i> should replace <i>Plotus</i> Linn.
<i>Cochlearius</i> should replace <i>Cancroma</i> Linn.
<i>Anhima</i> should replace <i>Palamedea</i> Linn.
<i>Jacana</i> should replace <i>Parra</i> Linn.

The following 5 names in Sharpe's 'Handlist' are wrongly attributed to Brisson, as they were not (except in the case of *Vultur* and *Emberiza*) employed by him as generic names:

<i>Fregata</i> — dates from Lacépède, 1799.
<i>Botaurus</i> — dates from Stephens, 1819.
<i>Steganopus</i> — dates from Vieillot, 1819.
<i>Vultur</i> — dates from Linnæus, 1758.
<i>Emberiza</i> — dates from Linnæus, 1758.

<sup>1</sup> The untenable are: *Meleagris* (as used by Brisson), *Gallopavo*, *Coracia* (if too near *Coracias* Linn.; if available *Coracia* Briss. will replace *Graculus* Koch, now in current use for *Coracia* Briss.), *Galgulus*, *Ispida*, *Pluvialis*, and *Corirra*.

## THE RELATION OF SIX BRISSONIAN GENERA TO LINNÆAN GENERA.

The relation of 6 Brissonian genera to Linnæan genera is somewhat involved. These genera are *Merganser*, *Meleagris*, *Ispida*, *Galbula*, *Cotinga*, and *Tangara*, here considered in further detail.

**Mergus** Linnæus AND **Merganser** Brisson.

The genus *Mergus* Linnæus (1758) contained five species (one of them a synonym), without designation of type; *Merganser* Brisson (1760) contained the same species and nothing else. *Merganser* is therefore a homonym of *Mergus*. The tautonymic type of *Merganser* is *Mergus merganser* Linn., which, under Art. 30f of the International Code of Zoölogical Nomenclature, is also the type of *Mergus*.

**Meleagris** Linnæus AND **Gallopavo** Brisson.

*Meleagris* (1758) was founded with three species, and no type was designated. *Gallopavo* (1760) contained two species, both of them species of *Meleagris*, with *Meleagris gallopavo* Linn. the type by tautonymy. The third species of *Meleagris* (*M. satyra* Linn.) was transferred by Brisson to the genus *Phasianus*. *Gallopavo* is thus a substitute name for *Meleagris*. The type of *Gallopavo* (*Meleagris gallopavo* Linn.) thus also becomes the type of *Meleagris*, under Art. 30f of the International Code of Zoölogical Nomenclature, which reads: "(f) In case a generic name without originally designated type is proposed as a substitute for another generic name, with or without type, the type of either, when established, becomes *ipso facto* type of the other." (*Meleagris gallopavo* is the species commonly recognized as the type of *Meleagris*.)

**Alcedo** Linnæus AND **Ispida** Brisson.

*Alcedo* Linnæus (1758) originally contained 7 species (one of them indeterminate), no species being designated as type. Brisson in 1760 established *Ispida* for the kingfishers with *Alcedo ispida* Linn. as the tautonymic type. All of the original Linnæan species of *Alcedo* were kingfishers except one, *A. todus*, which Brisson removed in 1760 to his new genus *Todus*, of which it is the tautonymic type. *Ispida* being a substitute name for *Alcedo*, the type of *Ispida* (*Alcedo ispida* Linn.) is the type of *Alcedo* under Art. 30f of the International Code of Zoölogical Nomenclature, as it is also by subsequent designation (Boie, 1822, and Gray, 1840).

**Cotinga** BRISSON AND **Ampelis** LINNÆUS.

*Cotinga* Brisson (1760) contained ten species, of which two seem to be unidentifiable. The type of the genus is tautonymic — *Cotinga cotinga* Brisson = *Ampelis cotinga* Linn. 1766.

*Ampelis* Linnæus (1766) contained seven species, one of which is not satisfactorily identifiable. Five of them, as shown below,<sup>1</sup> are identical with six of Brisson's species of *Cotinga*, on which four of them are primarily based. The other identifiable species is *Ampelis garrulus*, placed by Brisson in *Turdus* as "*Bombycilla bohémica*."

Linnæus placed six of the eight identifiable Brissonian species of *Cotinga* in his genus *Ampelis*, one in his genus *Lanius*, and to the other he makes no reference. *Ampelis* is thus essentially a substitute name for *Cotinga*.

Of Linnæus's six identifiable species of *Ampelis*, *A. cayana* and *A. maynana* are congeneric with *A. cotinga*, the type of *Cotinga*; *A. garrulus* is congeneric with the type of *Bombycilla* Vieillot, 1807; *A. carnifex* became the type of *Phenicircus* Swainson (1832) by designation of Gray in 1840; *A. pompadora* became the type of *Xipholena* Gloger (1842) by designation of Gray in 1855. If *Ampelis* is not to be construed as a substitute name for *Cotinga*, its type is *A. pompadora*, the last species removed from the genus.

**Coracias** Linnæus AND **Galgulus** Brisson.

*Coracias* Linnæus (1758) contained 6 species and no type was indicated. *Coracias garrulus*, the first species, is the only one of the original species now retained in the genus and this species has long been recognized as its type.

<sup>1</sup>Species of *Ampelis* Linn. 1766.

1. *garrulus* (= *Lanius garrulus* Linn. 1758 = [*Turdus*] *Bombycilla Bohémica* Briss. 1760), congeneric with the type of *Bombycilla* Vieillot, 1807.
2. *pompadora* (= *Cotinga purpurea* Briss.), type of *Xipholena* Gloger, 1842.
3. *carnifex* (= *Cotinga rubra* + *C. cinereo-purpurea* Briss.) = *Lanius carnifex* Linn. 1758), type of *Phenicircus* Swainson, 1832.
4. *cotinga* ([*Cotinga*] *cotinga* Briss.), tautonymic type of *Cotinga* Brisson, 1760.
5. *maynana* (= *Cotinga maynanensis* Briss.), congeneric with No. 4.
6. *cayana* (= *Cotinga cayanensis* Briss.), congeneric with No. 4.
7. *tersa*, not satisfactorily identifiable.

Species of *Cotinga* Briss. 1760.

1. *cotinga* = *Ampelis cotinga* Linn. 1766.
2. *maynanensis* = *A. maynana* Linn.
3. *cayanensis* = *A. cayana* Linn.
4. *mexicana*, ex Fernandez and Ray; not identifiable.
5. *purpurea* = *A. pompadora* Linn.
6. *cinereo-purpurea* = *A. pompadora* Linn. ♂ juv.
7. *rubra* = *A. carnifex* Linn.
8. *cinerea* = *Lanius nengeta* Linn.
9. *navia*, not cited by Linn.; = *Ampelis variegata* Gmel.
10. *alba*, ex Joan de Laët; not identifiable.

*Galgulus* Brisson (1760) contained 10 species, with [*Galgulus*] *galgulus* (= *Coracias garrulus* Linn.) as type by tautonymy. Three of Brisson's species of *Galgulus* are now currently referred to *Coracias* Linn.

Brisson retained only one of Linnæus's species of *Coracias* in his genus *Galgulus*, which is its tautonymic type. He referred (in his supplement) two of the others to *Turdus*, and two to his new genus *Icterus*; to the other species he appears to have made no reference. It is thus evident that *Galgulus* Brisson is a substitute name for *Coracias* Linn. Under Art. 30f of the International Code of Zoölogical Nomenclature, the type of *Galgulus* determines the type of *Coracias*, which is fortunately the species hitherto recognized as its type.

### **Tangara** Brisson AND **Tanagra** Linnæus.

*Tangara* Brisson (1760) originally contained 30 species; type [*Tangara*] *tangara* Brisson (by tautonymy) = *Tanagra tatao* auct. ex Linn., 1766. *Tangara* will thus become the name of the genus now known as *Calospiza* Gray, 1840 (formerly *Calliste* Boie, 1829).

*Tanagra* Linnæus, 1764 (Mus. Adol. Frid., II, 30), contained originally only 3 species:

(1) *Tanagra militaris* = *Emberiza militaris* Linn., Syst. Nat., ed. 10, I, 1758, p. 178; now *Leistes* (Vigors, 1825) *militaris*.

(2) *Tanagra albirostris* = *Oriolus persicus* Linn., Syst. Nat., ed. 12, I, 1766, p. 161 = *Parus cela* Linn., Syst. Nat., ed. 10, I, 1758, p. 191; now *Casicus* (Cuvier, 1800) *cela*.

(3) *Tanagra violacea* = *Fringilla violacea* Linn., Syst. Nat., ed. 10, I, 1758, p. 122; now *Euphonia* (Desmarest, 1805) *violacea*.

Species 1 and 3 were included by Brisson four years earlier in his genus *Tangara*, and species 2 in his genus *Icterus*.

Two years later Linnæus (Syst. Nat., ed. 12, I, 1766, pp. 313-317) included 24 species in his genus *Tanagra*, one of which is a duplication (No. 18 = No. 12). Of the remaining 23 species, 21 were included in *Tangara*, 1 in *Icterus*, and 1 in *Muscicapa* by Brisson in 1760. It is from this second use of *Tanagra* by Linnæus (1766) that authors have almost universally taken this genus, instead of from the correct date, 1764.

In case it is held that *Tanagra* is available, its type must be one of the three species originally included in it—either *Tanagra militaris*, *T. albirostris*, or *T. violacea*.<sup>1</sup> Although *T. militaris* would naturally be the type,

<sup>1</sup> Gray in 1840 designated *Tanagra episcopus* as the type of *Tanagra*, but it was not one of the original species. In 1855 he changed the type to *Tanagra jacapa* Linn., which was also not one of the original species.



having been last removed from the genus (as shown above), Richmond, in 1908 (Proc. U. S. Nat. Mus., XXXV, p. 644, Dec. 16, 1908) designated *T. violacea* as the type, *Tanagra* thus replacing *Euphonia* (Desmarest, 1805), while *Thraupis* Boie, 1826 (type by monotypy, *Tanagra archiepiscopus* Desmarest, 1805 = *T. ornata* Sparrmann, 1789) will be the name for the genus now commonly recognized as *Tanagra*, as stated by Richmond (*l.c.*).

Under the A. O. U. Code of Nomenclature *Tanagra* is untenable, being an emendation of *Tangara*, both words being from the Brazilian word *tangara*, of which *Tanagra*, like "tanager," is an obvious variant.



**Article XXVIII.**—OBSERVATIONS ON THE HABITS AND DISTRIBUTION OF CERTAIN FISHES TAKEN ON THE COAST OF NORTH CAROLINA.

BY RUSSELL J. COLES.

The notes presented in the following pages are based on the writer's observations made while fishing at different seasons and at various points off the North Carolina coast between the years 1902 and 1910. Many of the specimens on which they are based have been donated to the Government Fisheries Laboratory at Beaufort, N. C., and to the American Museum of Natural History in New York, where the identifications have been corroborated.

I. ELASMOBRANCHII.

**Narcine brasiliensis** (Ölfers).

(SMALL ELECTRIC RAY.)

In July, 1909, I first saw this electric ray and captured two specimens which were presented to the Laboratory of the Bureau of Fisheries at Beaufort, N. C. They were the first recorded on our Atlantic coast north of Florida. In July, 1910, I captured and preserved eleven specimens at Cape Lookout and know of the capture of more than a dozen others by the native fishermen during the same week; and none were seen either before or after that week. This ray can give a very powerful electric shock. I have been knocked down many times by this shock while experimenting with the fish, yet could make no record of this peculiar form of electricity as it had no effect on my battery-testing ammeter and it would not light a little electric lamp which only required two and a half volts. Probably it might have been recorded with a volt meter, but I had none with me.

Several specimens which I found buried in the sand in shallow water with only the eyes and a little of the head and back showing were speared, and others were caught in the haul net.

Several bare-foot native fishermen were knocked down by accidentally stepping on them in shallow water. These rays remain soft and rubber-like in a formalin solution which hardens other specimens.

**Dasyatis hastata** (*De Kay*).

(STING RAY.)

My experience with this ray is confined to a specimen weighing sixty-four pounds caught in a haul seine in July, 1910. Many native fishermen stated that they had never seen a ray like it. All rays seem to possess a degree of intelligence very great for such sea creatures and this one appears to be second in intelligence only to the *Mobula olfersi* which is referred to later. When the specimen was prodded with a lance it exhibited great fury and time and again threw itself on its back as it slashed at me with its barbed tail. It would give forth a loud, harsh, discordant bark of baffled rage at its failure to reach me; and it showed unusual strength in being able to throw itself on its back and then right itself. While killing this ray it gave birth to five living young about six inches wide and fifteen inches long; it also contained five eggs about the size of 00 buckshot, five about the size of BB shot and five about the size of No. 1 shot.

**Aëtobatus narinari** (*Euphrasen*).

(SPOTTED STING-RAY; LADY-RAY.)

To the above names and many others by which this ray is called might be added most appropriately the name of "Sea-hog"; for after the manner of that quadruped this ray spends most of its time in plowing up the bottom of the sea with its tough hog-like snout in search of clams and other shellfish. Although it feeds in very shallow water at high tide, I have found it very difficult to harpoon owing to the fact that it keeps the water thick and clouded with sand by its continual rooting, making it almost impossible to locate its form with sufficient accuracy to strike true with the harpoon; and at the too near approach of the boat it suddenly darts away with great speed.

For many years I have given much time to the study of these rays and am thoroughly convinced that the shellfish consumed by the entire human race are as nothing to the countless thousands of bushels consumed each year by this ray. I have known of beds, containing many bushels of planted clams, being attacked by schools of these rays and every clam in them destroyed in less than a week; and on several occasions I have had a pile containing a half bushel or more entirely destroyed during a single tide by one or more of these rays. Clams appear to be almost, if not entirely, the only food of the ray. I have opened more than fifty specimens and

carefully studied the contents of the stomach and have never found that they contain any other food.

The mouth of this ray is especially interesting in that the upper jaw holds a quadrangular plate of stone-like hardness made up of a succession of thin plates on edge, and the lower jaw holds a long tongue-like plate of similar structure. Further, the thin plates at the back are more or less partly formed and soft, and, as the edge of the front thin plate becomes dull or broken it becomes loose and drops off, giving a new thin plate in front with knife-like edge; and the whole structure is forced forward and another plate becomes hard and stone-like. In fact it becomes so hard as to withstand a heavy blow from a hammer and to give out a sharp sound as if a very hard stone were struck. No ordinary blow of a hammer will fracture one of these plates.

The muscular development of these jaws is truly wonderful. I have found in these rays clams which with their shells on must have weighed more than three pounds and to crack which a pressure of perhaps a thousand pounds would be required. And I have found in the stomach of these rays on a number of occasions more than half a gallon of freshly opened clams, with the flesh of each clam less broken than the most expert human clam opener could possibly have turned out; and the writer has often spread out these clams on a clean board and carefully examined them and found that they were absolutely free from any pieces of broken shell.

*Aëtobatus narinari* is a dweller in the warm seas, yet every summer it comes as far north as Cape Lookout, N. C., in great numbers, and it is occasionally reported on the Virginia coast but considered very rare there. In going from one good feeding ground to another they at times move in large schools. On or about July 20, 1909, the writer while on his yacht about ten miles south of Cape Lookout noticed a large school containing many hundreds of them on one of these migrations, passing swiftly but silently along under the yacht about three feet under water going south in regular, close marching military formation. Furthermore there is absolutely reliable information that others have seen these migrations on a number of occasions just as this one was seen.

During 1909 they were remarkably plentiful at Cape Lookout. I captured more than fifty specimens and saw a great many more, in addition to the above mentioned school. During July, 1910, the writer probably saw as many as forty or fifty specimens but killed only eight; the largest of which was 5 ft. 9 ins. wide; total length including tail 8 ft. 9 ins.; length of tail 5 ft. 9 ins.; length of body 3 ft.; weight 132 lbs. This was a female without eggs or embryos. My largest specimen of this ray was captured at Cape Lookout in July, 1904; its weight was estimated by myself

and others who assisted in handling it to be between five and six hundred pounds. Unfortunately I made no measurements of this specimen. It was, however, by far the largest I have ever seen.

For a number of years, members of my crew and other deep sea fishermen have been telling me that in giving birth to its young the female ray leaps high in the air as each of its young is born; but as this leaping seemed so unnecessary I had questioned their tales. However, on about the 15th of July, 1910, I was suddenly called on deck by two of my crew and then saw a large female *Aëtobatus narinari* leaping high in the air and falling back into the water within twenty yards of the yacht. After she had thus leaped several times, I distinctly saw a young one about six or eight inches wide thrown from her body; and, after she had leaped again several times without result, another young one was born; and the men told me that two had been born before I had come on deck.

The *Aëtobatus narinari* carries near the base of its tail from two to four barbed spines. The largest, which is the one used in stinging, is the one farthest from the body. From my personal observations I know that, if the tip of this sting becomes broken, the sting soon gets loose and drops out and the one in front grows larger and takes its place; and where this change is taking place another small, half-soft, sting is forming under the skin behind the dorsal fin to take its place later on should the two or three behind become injured or damaged and have to be cast off.

The barbed spine of this ray is covered with a mucous slime containing a violent poison and a person stung by the *Aëtobatus narinari* suffers the most horrible torture for many days; and there are many authenticated cases in which permanent disability, loss of leg or arm, or even death has resulted. I can write most feelingly on this subject as in my work of collecting and making studies of rare fish, I have been for years more or less exposed to this danger and have been experimenting and trying to find the proper treatment in such an emergency. On the morning of July 12, 1910, while handling a large specimen of *Aëtobatus narinari* which had been just caught, it suddenly threw its body against me and drove its poisoned sting into my leg above the knee for more than two inches, striking the bone, and producing instantly a pain more horrible than I had thought possible that man could suffer. The only sensation comparable to it, which I have ever experienced, is that produced by coming in contact with the long filaments of the Portuguese Man-of-War. I braced myself against the body of the creature and tore its barbed spine from my flesh. In less than five minutes I had attached a long needle to a hypodermic syringe, inserted the needle to the bone in the wound and injected a syringe of full strength antiseptic solution called Formolid. This was repeated until

the wound had been thoroughly cleared of the poisonous slime carried in by the spine. The result was magical, the pain did not subside; it stopped instantly; and the wound had entirely healed in less than 24 hours.

***Mobula olfersi* (Müller and Henle).**

(SMALL DEVIL-FISH.)

One night in July, 1910, I captured my first *Mobula olfersi* in a great drift net, near Cape Lookout, N. C. It was a female which had thoroughly tangled itself up in the net and was easily taken into the boat and preserved for the American Museum of Natural History. The next morning I caught a male *Mobula* in a haul seine and likewise preserved it for the museum. A school of them was then found containing certainly as many as 25 or 30, and possibly 100 or more; and for two days I gave up all other fishing for the purpose of devoting my entire time to their study; and having already secured two specimens, I withheld from harpooning and shooting any others as they leaped near the whale boat, in which I was following and keeping as close as possible to them. The following facts were noted.

In capturing minnows for food *Mobula olfersi* exhibits what appears to be great reasoning power. They fish in squads of three or more, as I saw them do while standing for several hours, on the evening of the second day, on a point of beach where there was a great school of minnows (*Fundulus majalis*). First a squad of four Mobulas came towards the beach, through the shallow water, and as they neared the school of minnows the one nearest the shore stopped; the other three wheeled around in a semicircle, rushed in on the minnows until they were right up on the sand, where I and a dozen or more native fishermen were standing, until their bodies were nearly half out of the water; but in an instant they were off and scattered out to sea. Then in a few minutes the minnows would again congregate and back would come the Mobulas. During a period of two hours they returned on an average of about every seven minutes; and as there was a slight difference in their sizes, I was soon able to note that each one kept its relative position and the same one (which was slightly smaller than the others) was always the one that stopped first, nearest the sand.

I harpooned one and it rushed off with great speed, making two hundred feet of small rope burn my hands, but I soon had it on shore. After this the two remaining ones returned twice, and then came again bringing three others with them. After watching the five fish several times, I had a large, strong seine run around them and hauled them on shore; and with the seine set around to prevent their escape, I took one of them into the water

with me and handled it and studied the details of its movements for some time. I noted especially its eyes. *Mobula* can see nothing small directly in front or behind; but it can move the eyes freely upward and downward so that it can see directly below and above just as well as on both sides. The point of peculiar interest is that the eyes move absolutely independently of each other, giving the fish at the same time two distinct fields of vision. This point I verified a number of times as I stood with the fish in three feet of water. I saw it watching the movements of my hands above its head with one eye and watching my foot, which kept moving close under it, with the other eye. This same peculiarity I had noted the day before while passing over one in a whale boat.

The horns are not movable and cannot close and grasp anything between them. I tested this repeatedly by striking the fish between the horns with both my leg and arm; but there was not the least contractile movement of the horns. The tales that come up from the sea of ships' anchors being grasped by the horns of the Manta and the vessels towed many miles to sea are not based on fact. But after seeing the Great Devil-fish in 1909 and studying numbers of small ones, it seemed to me possible for some of these great rays, if accidentally striking head-on against the cable of a ship of small tonnage, to drag it for a short distance to sea until the fish falls exhausted or even dead. That the fish might exert itself until it falls dead is supported by the fact that on several occasions I noted that some varieties of shark (notably *Sphyrna zygaena*) when hooked and properly played with rod and reel, will continue their mad rushes until they suddenly drop dead from overexertion. The same thing might occur with the Great Devil-fish.

The mistaken idea that the Manta grasps and holds things between its horns comes from the fact that it carries wide, thin appendages, or flexible flaps, folded around them. *Mobula*, when charging upon a school of minnows, opens wide its great mouth and unfolds these appendages until they meet together below the mouth and form a great funnel into which it scoops the minnows; but the instant that the rush is over it curls them back tightly around the horns again. It also folds and unfolds them after capture, but when lying on the bottom or swimming slowly, keeps them tightly curled up.

All the nine *Mobulas* caught by me, of which two were males and seven females, were carefully examined and it was found that their stomachs contained only very finely masticated minnows. Moreover, the structure of their teeth and jaws absolutely precludes the possibility of their ever crushing and eating shellfish. None of the specimens examined contained embryos or eggs.



Their flesh, when the sunlight shone through thin steaks of it, had a brilliant light red color. I had some of it prepared for the table on board my yacht and my crew and I found that Small Devil-fish makes very fine eating; in fact I had never eaten flesh of any kind that came out of the sea that equals it.

When fishing for minnows the Mobula rushes through the water with a speed that is almost inconceivable and even when very near the surface makes scarcely a ripple on the water; and their lines and movements might be studied with possible results, by naval and air-ship constructors, as the stroke of their "wings" is very different from that of other rays and many times more rapid. Every stroke changes the color of the white below and the black above so rapidly as to produce the optical illusion that the color of the back is gray. When first caught the back is a perfect black, which very quickly changes to a beautiful very dark blue.

One of my most interesting observations was on the sound they make when taken out of the water: they give forth at frequent intervals a musical bell-like bark, something like the bark made by the beagle hound when it has its game treed. It is entirely different from the harsh, discordant grunt or bark made by some of the rays; although many varieties of rays make no sound at all when dying.

I also noted that the Mobula leaps in the air more often and leaps higher, than other rays; and as they leaped a great number of times very near my boat, during the two days that I studied them, I had the opportunity of noting details closely and came to the conclusion that this leaping was done purely for sport and not to detach pilot fish (*Remora*), or to give birth to young; which latter event I had the opportunity of observing during the summer of 1910, in a large spotted sting ray (*Aetobatus narinari*), as recorded on a preceding page of this paper.

By far the most interesting observation that I made, however, was that on the copulation in this species. My attention was first called to it by seeing a number of native fishermen out in their boats, watching something and signaling to me; and as we hurried to them in a whale boat we saw that it was a male and female Mobula *in copulo*. Being afraid to disturb them I did not go very close to them, but saw them soon separate and for more than half an hour I observed one or both of them frequently leap high in the air. Then they came together again, so as to give me a good opportunity of observing them at close range. The male was above with back just showing above the water and his wing-like pectorals curved upward until they stood straight up above his back; while the female was oriented so as to plainly show the white side uppermost, with pectorals standing up, firmly grasping the male; and apparently by a movement of the ventral

fins they were gliding very slowly through the water in circles and figure eights. Again after about ten minutes *in copulo*, they separated; and for nearly an hour they frequently leaped near the boat as I slowly followed them; and then they again came together. Copulation was not accomplished by a vertical motion, but by a graceful, serpentine lateral curvature of the spine, as the male alternately advanced one of the mixopterygia as he withdrew the other.

## II. TELEOSTEI.

### **Ophichthus ocellatus** (*Le Sueur*).

(SPOTTED SNAKE-EEL.)

There is no record of this eel having been taken on the North Carolina coast before I captured a specimen at Cape Lookout in April, 1910. It is a rare member of quite a large family of eels. It lies buried in the sand with only the head showing and only at very rare intervals does it come out of the sand and drift about in the sea in an almost perpendicular position with head uppermost. At such times it offers an easy prey to other fish, as I had an opportunity of observing in July, 1908. An eel of this family (*Bascanichthys scuticaris*) had come out of its bed and was drifting along. As I neared it in my skiff a school of *Auxis thazard* came rushing by and I saw several of them snap at the eel and bite off several inches of its tail. They would soon have eaten it entirely if it had not been scooped into my skiff.

### **Albula vulpes** (*Linnæus*).

(LADY-FISH.)

In nine years' summer fishing at Cape Lookout, N. C., I have secured only one specimen, in July, 1910. It is unknown to most of the native fishermen; but two reliable men reported that on one occasion in the fall, they caught quite a number of them in a seine and that they cooked and ate some of them and found them of excellent flavor, but the fish were too bony to have a commercial value.

### **Synodus foetens** (*Linnæus*).

(LIZARD FISH.)

Fairly common at Cape Lookout in July; solitary in habit, as I have never seen two near each other. Have caught them with hook, haul seine,

and spear. At night they come into shallow water and I have speared them as they were lying motionless under eel grass, alongside a piece of timber or partly buried in the sand.

***Sphyræna borealis* De Kay.**

(NORTHERN BARRACUDA.)

Very rare at Cape Lookout, many native fishermen never having seen it. I have seen but three specimens — one of them captured in July, 1909, and two in July, 1910.

***Polydactylus octonemus* (Girard).**

(THREADFIN.)

This fish appears to be entirely unknown on the North Carolina coast. When the specimen which I caught at Cape Lookout in April, 1910, was shown to nearly a hundred native fishermen and fish dealers, all said that they had never seen a fish like it. It is almost the only fish that I ever caught at Cape Lookout that neither I nor some native did not recognize and have some name for. Smith's 'Fishes of North Carolina' contains no record of this fish.

***Vomer setipinnis* (Mitchill).**

(MOON-FISH.)

Rather rare at Cape Lookout; and it is a very rare occurrence when more than two are taken at a single haul of the seine. But in July, 1910, I caught about 100 pounds of them at a single haul of the seine.

It is not generally known that this fish is a good food fish, but I have found it to be one of the most delicious food fish that I have ever tasted.

***Trachinotus carolinus* (Linnæus).**

(CAROLINA POMPAÑO.)

Adult specimens of this fish are quite rare at Cape Lookout but the young are more often seen there in July.

***Rachycentron canadus* (Linnæus).**

(CRAB-EATER.)

Not very rare at Cape Lookout, but always appearing as a lone straggler and usually found in company with *Scomberomorus maculatus*. It has not

the appearance of being a food fish, but a surprise is in store for the man who eats one for the first time, as it is really a most excellent food fish.

**Lobotes surinamensis** (*Bloch*).

(TRIPLE-TAIL; FLASHER.)

This fish appears rarely at Cape Lookout and then only as a straggler. In July, 1909, I secured a specimen weighing 26 pounds in a seine, and as the seine was being hauled up into shallow water, it rushed from one side of the net to the other, making a wake in the water greater than any other fish of many times its weight could make. It is from this peculiarity that it has derived its local name of "Steamboat." In July, 1909, another large specimen was seen. It was lying on its side on top of the water alongside a box drifting at sea, and I thought it dead or might have captured it with a light harpoon; but when the boat came within a few feet of it the fish suddenly darted away. Native fishermen say that on a number of occasions they have seen a single specimen acting in a similar way alongside a piece of drifting wreckage. In July, 1910, only a single specimen was seen and captured and that of only about one pound.

**Cynoscion nothus** (*Holbrook*).

(BASTARD WEAKFISH.)

A very rare and interesting fish of which I have caught only two specimens, one in January, 1910, at New River Inlet and one at Cape Lookout in April, 1910. It always appears as a solitary straggler and native fishermen say that they have never caught more than one in a haul of the seine.

**Menticirrhus americanus** (*Linnaeus*).

(CAROLINA WHITING.)

This fish is found at Cape Lookout during every month of the year, being caught in sink nets in late winter and early spring in great numbers, and only occasionally and in small numbers at other times. It is distinctly a bottom feeder and remains in one locality long enough for its color and flavor to be entirely changed by the bottom on which it is feeding. I have often taken these fish with the hook and eaten them and may note that specimens caught in deep water on a hard sandy bottom, are good food fish, while those caught on a soft muddy bottom are much darker in color and the flesh has such a rank mud flavor as to be almost unfit for food.

**Menticirrhus littoralis** (*Holbrook*).

(SURF WHITING.)

A most delicious food fish which would at all times command the highest market price but for the fact that all market fishermen and fish dealers consider it the same as the *Menticirrhus americanus*; and the latter kills the reputation which the former makes as a food fish.

**Iridio bivitatus** (*Bloch*).

(SLIPPERY DICK.)

The name "Slippery Dick" by which this fish is commonly called but faintly describes its slipperiness. Small eels would be easy to hold in the hand in comparison, as it can come just out between the fingers of a tightly closed hand. It is comparatively rare at Cape Lookout, although in July, 1910, several specimens were secured in the eel grass in shallow water.

**Lagocephalus lævigatus** (*Linnaeus*).

(SMOOTH PUFFER.)

This peculiar puff-fish with the rabbit face is rare at Cape Lookout and is so considered by native fishermen. It appears there only as a straggler and I have caught only three specimens of it, two in July, 1909, and one in July, 1910; all taken with the seine.

**Astroscopus y-græcum** (*Cuv. and Val.*).

(STAR-GAZER.)

I have found only three specimens of this fish at Cape Lookout. It is very rare there. In July, 1904, while spearing flounders by firelight in shallow water at night, one of these fishes was observed buried in the sand with only part of its back and head showing. It was speared and found to be much the largest specimen that I had ever seen, being more than fifteen inches long. In July, 1909, a small one was secured in the seine; and in the same way another was secured in July, 1910.

All three specimens gave me their electric shock a number of times. While the shock is very distinct it is only about one-tenth the strength of the shock that a *Narcine brasiliensis* of the same weight would give.

***Ancylopsetta quadrocellata* Gill.**

(ROUGH FLOUNDER.)

One of the rarest of a number of flounders found at Cape Lookout. It does not feed in very shallow water at night as other flounders do and is rarely, if ever, speared. I have never taken one with the hook; the few specimens that I have seen were caught in the seine.

## INDEX TO VOLUME XXVIII.

New names of genera, species and subspecies, and of higher groups are printed in **heavy-face** type; also the main references in a series of references.

- ACCIPITER, 324, 328, 331.  
 Adjidaumo, 59.  
 Ælurietis, 289, 294, 308.  
 Ælurotherium, 289.  
 Ænasilus, 84.  
     **cæruleus**, 84.  
     chapadæ, 84.  
     hyettus, 84.  
 Æshna larvata, 276.  
 Aëtobatis narinari, 338-340, 343.  
 Agouti, 88.  
     paca virgata, 96.  
**Agræcomyrmex**, 265.  
 Akodon, 88.  
     teguina, 98.  
 Albatrus, 330.  
 Albertosaurus, 269.  
 Albula vulpes, 344.  
 Alca, 329.  
 Alcedo, 328, 332.  
     ispida, 332.  
     todus, 332.  
 Alepidophora, 288.  
 Allen, J. A., the Black Bear of Labrador, 1-6; mammals from the Athabaska-Mackenzie region of Canada, 7-11; mammals from Palawan Island, Philippine Islands, 13-17; additional mammals from Nicaragua, 87-115; mammals from the Caura district of Venezuela, with description of a new species of *Chrotopterus*, 145-149; collation of Brisson's genera of birds with those of Linnæus, 317-335.  
 Allomys, 71.  
 Allosaurus, 192, 195.  
 Alosaurus, 207.  
     gracilis, 208.  
 Alouatta, 88.  
     macconnelli, 148.  
     palliatæ, 114.  
     palliatæ matagalpæ, 92, 114.  
 Ampelis, 328, 330, 333.  
     carnifex, 333.  
     cayana, 333.  
     cotinga, 333.  
     garrulus, 333.  
     maynana, 333.  
     pompadora, 333.  
 Amphiacusta caraibea, 77.  
 Amphiuma, 215.  
 Amynodon, 235, 240.  
     antiquus, 240.  
 Anaptomorphus homunculus, 250.  
 Anas, 325, 329.  
 Ancylosetta quadricellata, 348.  
 Andricus, 128, 136.  
     nigræ, 134.  
     pruinosa, 131.  
     tumifica, 134.  
 Anhima, 329, 331.  
 Anhinga, 329, 330.  
 Anomodontia, 210.  
 Anoura geoffroyi, 111.  
 Anser, 325, 329, 331.  
 Anthobosca antennata, 278.  
     iheringii, 278.  
 Anthodon, 201.  
 Antistrophus pisum, 142.  
 Anurogryllus muticus, 77.  
**Anusioptera**, 83.  
     **aureocincta**, 83.  
 Aonyx cinerea, 17.  
 Aotus, 114.  
     rufipes, 114.  
 Apiaster, 330.  
 Apis mellifera ligustica, 283.

- Aplodontia, 44, 47, 48, 61, 64, 65, 69, 71.  
 Aplodontiidae, 69, 71.  
 Aplodontoidea, 69.  
**Apsychomyrmex**, 261, 262, 265.  
     **myops**, 261.  
**Apternodontinae**, 35.  
 Apternodus, skull of, 33-36.  
 Apternodus mediaevus, 33, 241.  
 Aquila, 324, 328, 331.  
 Ara, 326.  
 Archaeosuchus, 200, 205, 207, 233.  
 Archegosaurus, 214.  
 Arctictis, 13, 16, 115.  
     **whitei**, 15-17.  
 Arctitis, in error; see Arctictis.  
 Arctomys, 46-49, 61, 70, 71.  
     monax, 52.  
 Acrepithecus castaneiceps, 91, 93.  
     griseus, 93, 94.  
 Ardea, 329.  
 Arenaria, 329, 331.  
 Artibeus jamaicensis jamaicensis, 112.  
     jamaicensis richardsoni, 91, 112.  
     toltecus toltecus, 113.  
     watsoni, 112.  
 Asclepiadiphila stephanotidis, 142.  
 Asio, 324, 328, 331.  
**Aspidosauridae**, 179.  
 Aspidosaurus chiton, 179, 180.  
     **glascocki**, 179.  
         (Zatrachys) apicalis, 179.  
         (Zatrachys) crucifer, 179.  
 Astrocopus y-graecum, 347.  
 Ateles, 88.  
     geoffroyi, 114.  
     variegatus, 148.  
 Aulacidea, North American species of, 253-258.  
 Aulacidea ambrosiæcola, 256.  
     bicolor, 253.  
     cavicola, 257.  
     harringtoni, 257.  
     mulgediicola, 256.  
     nabali, 256.  
     podagre, 254.  
     solidaginis, 254.  
     sonchicola, 254.  
     tumida, 253-255, 258.  
 Aulax mulgediicola, 253.  
 Avocetta, 330.  
 Aylax, North American species of, 137-258.  
 Aylax, 253.  
     bicolor, 143.  
     chrysothamni, 143.  
     gillettei, 141.  
     glechomæ, 138.  
     laciniatus, 140.  
     leavenworthi, 139-141.  
     minor, 142.  
     pisum, 142.  
     rufus, 141, 142.  
     silphii, 140.  
     taraxaci, 142.  
 BATOMYS, 89, 101.  
 Balantiopteryx io, 110.  
     plicata, 110.  
 Balearica, 329, 331.  
 Bassariæyon, 89.  
     richardsoni, 91, 106.  
 Bassariscus, 89.  
     sumichrasti, 107.  
     variabilis, 107.  
 Bathyergus, 65.  
 Bathyopsis, 243.  
 Batrachosuchus, 233.  
 Beutenmüller, W., the North American species of *Neuroterus* and their Galls, 117-136; the North American species of *Aylax* and their Galls, 137-144; the North American species of *Aulacidea* and their Galls, 253-258.  
 Bittacomorpha, 281.  
     **miocenica**, 280.  
     sackenii, 281.  
 Blarina, 89, 110.  
     olivacea, 91, 110.  
 Blennius **fabbri**, 161.  
     fucorum, 161.  
 Bombycilla, 333.  
     bohemica, 333.  
 Botaurus, 331.  
 Bothryiceps, 233.  
 Bradypus, 88.  
     castaneiceps, 90.  
     griseus, 91, 93.



- Bradypus tridactylus flaccidus*, 145.  
*Branchiosaurus*, 195.  
 Brisson as an ornithologist, 317-335.  
 Broom, R., a comparison of the Permian reptiles of North America with those of South Africa, 197-234.  
 Brown, B., the Cretaceous Ojo Alamo beds of New Mexico with description of the new Dinosaur genus *Kritosaurus*, 267-274.  
 Brues, C. T., some parasitic Hymenoptera from Vera Cruz, Mexico, 79-85.  
*Bucco*, 328, 330, 331.  
*Buceros*, 330.  
*Buphaga*, 328, 330, 331.  
*Buphagus*, 328, 330, 331.  
  
*CABASSOUS centralis*, 94.  
*Cacatua*, 326.  
*Callirhytis*, 136.  
*Calliste*, 334.  
*Calospiza*, 334.  
*Caluromys*, 88.  
     *laniger pallidus*, 92.  
*Calyptomyrmex*, 265.  
*Camelidæ*, 248.  
*Camelodon*, 248.  
     *arapahovius*, 248.  
*Canceroma*, 329, 331.  
*Canis latrans*, 11.  
     *occidentalis*, 10.  
*Capnobotes silens*, 280.  
*Caprimulgus*, 325.  
*Capromys brachyurus thoracicus*, 90.  
*Captorhinus*, 185, 187, 194, 195.  
*Caranx elecate*, 159.  
     *forsteri*, 159.  
     *hippos*, 159.  
     *latus*, 159.  
     *marginatus*, 159.  
     *rhabdotus*, 159.  
*Cardinalis*, 326, 327.  
*Cardiocephalus sternbergii*, 178.  
*Carduelis*, 327, 328, 331.  
*Cariacus clavatus*, 90, 91.  
*Cariama*, 329, 331.  
 Case, E. C., new or little known reptiles and amphibians from the Permian(?) of Texas, 163-181; the skeleton of *Pæcilospondylus francisi*, a new genus and species of Pelycosauria, 183-188; description of a skeleton of *Dimetrodon incisivus* Cope, 189-196.  
*Casicus cela*, 334.  
*Casuaris*, 329, 331.  
*Castor*, 70.  
*Castoridae*, 70, 71.  
*Castoroides*, 70, 71.  
*Castoroididae*, 70.  
*Catarractes*, 329, 331.  
*Cebus*, 88.  
     *apiculatus*, 149.  
     *capucinus*, 115.  
     *hypoleucus*, 115.  
*Centurio senex*, 113.  
*Ceratinoptera diaphana*, 73.  
*Ceratogaulus*, 69, 71.  
*Cercopithecus*, 151.  
*Chalicomys*, 70.  
*Charadrius*, 329.  
*Chilonycteris personata*, 110.  
     *rubiginosa*, 110.  
*Chiroderma salvini*, 112.  
*Chironectes*, 88.  
     *minima*, 93.  
*Chloris*, 326.  
*Chæronycteris godmani*, 111.  
     *mexicana*, 111.  
*Cholæpus*, 88.  
     *hoffmanni*, 93.  
*Chrotopterus*, 145.  
     *auritus*, 111, 148.  
     *carrikeri*, 147.  
*Ciconia*, 329, 331.  
*Cistecephalus*, 197, 211, 213.  
*Citellus (Colobotis) parryi*, 8.  
*Claosaurus agilis*, 273.  
     *annectens*, 270.  
*Clepsidrops*, 199.  
*Coccothraustes*, 328, 331.  
*Cochlearius*, 329-331.  
 Cockerell, T. D. A., fossil insects and a crustacean from Florissant, Colorado, 275-288.  
*Coëndou*, 89.  
     *mexicanus*, 96.

- Cænopus, 240.  
 Coles, R. J., observations on the habits and distribution of certain fishes taken on the coast of North Carolina, 337-348.  
 Colius, 328, 331.  
 Colonomys, 60.  
 Columba, 324, 326.  
 Colymbus, 329.  
 Conepatus **nicaraguæ**, 91, **106**.  
 Conocephalus fasciatus, 76.  
 Coracia, 328.  
 Coracias, 328, 333, 334.  
     garrulus, 333, 334.  
 Corrira, 329.  
 Corvus, 328.  
 Coryphodon, 240.  
     testis, 239, 240.  
 Cosila chilensis, 278.  
     donaldsoni, 278.  
 Cotinga, 328, 330-333.  
     cotinga, 333.  
 Coturnix, 326.  
 Crax, 326.  
 Creosaurus, 195.  
 Cricotus, 214.  
 Cryptocynodon, 198, 211.  
 Ctenosaurus koeneni, 176.  
     **rugosus**, 176.  
 Cuculus, 325.  
 Cyclopes, 88.  
     dorsalis, 94.  
 Cycloturus didactylus, 90.  
 Cylindrodon, 64, 69, 71, 241.  
     fontis, 33, 240.  
 Cynochampsa, 197.  
 Cynodictis paterculus, 33.  
 Cynodontia, 197.  
 Cynognathus, 198.  
 Cynomys, 70, 71.  
 Cynoscion nothus, 346.  
 Cypris **florissantensis**, 288.  
  
 DASYATIS hastata, 338.  
 Dasyprocta, 89.  
     punctata, 96.  
 Dasypterus ega, 113.  
     ega panamensis, 113.  
 Delphinognathus, 198, 201, 205, 206.  
  
 Dermochelys, 169.  
 Derobrochus crateræ, 275.  
     **typharum**, 275.  
 Deromyia angustipennis, 283.  
 Desmodus rotundus, 113.  
 Deuterosaurus, 205.  
 Diadectes, 195, 199, 204, 214-216, 231, 232.  
     **maximus**, 174.  
     phaseolinus, 163-173.  
 Diaphorocetus, 31.  
**Diasparactus zenos**, 174.  
 Diastrophus, 137.  
 Dielidurus alba, 110, 111.  
     virgo, 110.  
 Dicotyles labiatus, 90.  
 Dicrostonyx hudsonius alascensis, 10.  
 Dicynodon, 197, 198, 201, 210-212, 223.  
 Didelphis mesamericana tabascensis, 93.  
     opossum, 90.  
     richmondi, 91, 93.  
 Didus, 329, 331.  
 Dimetrodon, 189, 190, 193-195, 199, 200, 214, 221, 224-228.  
     gigas, 168, 171.  
     incisivus, 189-196.  
 Dinictis (*passim*), 289-313.  
     bombifrons, 310.  
     cyclops, 310.  
     felina, 310.  
     fortis, 310.  
     major, 311.  
     paucidens, 310.  
     squalidens, 310.  
 Dinobastis, 316.  
 Dinocephalia, 205.  
 Diochotichus, 31.  
     vanbenedeni, 19-30, 32.  
 Diomedea, 318, 329, 330.  
 Diphylla ecaudata, 113.  
 Diplacodon, 240.  
 Diplocaulus, 214, 233.  
 Dipodidæ, 72.  
 Dipodomys, 70, 71.  
 Dipoides, 70.  
 Dissorophus, 179.  
 Dromasauria, 204.  
  
 ECCASAURUS, 200.

- Echinomys semispinosus, 90.  
 Ectophylla alba, 90, 91, 112.  
 Edaphosaurus, 190, 214, 221-224, 226, 230.  
     pogonias, 221.  
 Elliot, D. G., on the genus *Presbytis* Esch., and 'Le Tarsier' Buffon, with descriptions of two new species of *Tarsius*, 151-154.  
 Emberiza, 331.  
     militaris, 334.  
 Endothiodon, 197.  
 Entoptychus, 68, 70, 72.  
 Eohippus, 239, 240.  
     venticolus, 236.  
 Eotitanops, 243, 246.  
     borealis, 243.  
     brownianus, 243.  
**Eotylopus**, 36-42.  
     **reedi**, 36.  
 Ephemera howarthi, 276.  
 Epigaulus, 69, 71.  
 Epilampra, 73.  
     burmeisteri, 74.  
     caraibea, 74.  
     insularis, 74.  
     microspila, 74.  
     sabulosa, 74.  
     **wheeleri**, 73.  
 Epimys rattus, 101.  
 Eptiseus, 89.  
     fuscus miradorensis, 113.  
     fuscus propinquus, 113.  
 Erethizon, 72.  
 Erethizontidæ, 72.  
 Ericulus, 34, 35.  
 Eriocampa bruesi, 277.  
     ovata, 277.  
     **pristina**, 276.  
     scudderi, 277.  
 Erioptera caliptera, 282.  
 Eryops, 180, 185, 214, 232.  
 Esoterodon, 211.  
 Etoptychoptera, 281.  
 Etoptychopterinae, 281.  
 Eucastor, 70, 71.  
 Euhapsis, 71.  
 Eumops abraxas, 114.  
 Eumys, 68, 72.  
 Eunotosaurus, 198.  
 Euphonia, 335.  
     violacea, 334.  
 Eurhinodelphis, 23, 24, 27.  
 Eusmilus, 289, 308, 313.  
     bidentatus, 313.  
     dakotensis, 314.  
 Eutamias, 7.  
     borealis, 8.  
 Eutypomys, 68, 70, 71.  
 Evotomys dawsoni, 9.  
     gapperi athabascæ, 9.  
 FALCO, 323, 324, 328.  
 Fallenia, 285.  
 Felidæ, phylogeny of, 289-316.  
 Felinae, 307, 308.  
 Felis, 290-295, 298, 304-307, 312.  
     bangsi costaricensis, 108.  
     costaricensis, 108.  
     eyra, 110.  
     jaguarundi, 110.  
     minuta, 15, 109.  
     onca centralis, 107.  
     pardalis mearnsi, 108, 109.  
     pardalis minutus, 109.  
     pardinoides oncilla, 110.  
     sp. indet., 108, 109.  
     tigrina, 109.  
 Fiber, 72.  
 Ficedula, 330.  
 Francolinus, 326.  
 Fratercula, 329, 331.  
 Fregata, 331.  
 Fringilla, 324, 326, 328.  
     violacea, 334.  
 Fulica, 329.  
 GALBULA, 328, 331, 332.  
 Galechirus, 198, 200, 204, 205, 209, 210.  
     scholtzi, 204.  
 Galepus, 200, 205, 209, 210.  
     **jouberti**, 204.  
 Galesaurus, 197, 198, 207.  
 Galgulus, 328, 333, 334.  
     galgulus, 334.  
 Gallinula, 329, 331.  
 Gallopavo, 330, 332.  
 Gallus, 328, 331.

- Garrulus, 328, 331.  
 Geomyiidae, 70, 72.  
 Geomys, 70, 72.  
 Geotipha, 278.  
     foxiana, 278.  
     **halictina**, 279.  
     **sternbergi**, 277.  
 Glareola, 329, 331.  
 Glossophaga mutica, 111.  
     soricina, 111.  
 Gomphognathus, 198.  
 Gopherus polyphemus, 173.  
 Gorgonops, 201, 205, 207.  
 Gracula, 328.  
 Graculus, 328.  
 Granger, W., Tertiary faunal horizons  
     in the Wind River Basin, Wyoming,  
     with descriptions of new Eocene  
     mammals, 235-251.  
 Grison, 89, 106.  
     canaster, 106.  
 Guerlinguetus, 88.  
**Gymnarthria**, 177.  
**Gymnarthridæ**, 177.  
**Gymnarthrus**, 177, 214, 219, 220.  
     **willoughbyi**, 177.  
 Gymnoptychus, 59, 68, 70, 71.  
     chrysodon, 62.  
  
 HEMATOPUS, 330.  
**Hecatasaurus**, 273.  
 Heleophilus, 200, 204.  
 Heleosaurus, 200, 204.  
 Heliscomys, 70, 71.  
 Helobia hybrida, 282.  
 Heloderma, 172.  
 Hemiacodon, 250.  
 Hemiblabera manca, 76.  
 Hemiderma castaneum, 111.  
     perspicillatum aztecum, 111.  
 Heptodon, 243.  
 Hermetia, 287.  
 Hermetiella, 287.  
 Herpestes brachyurus, 17.  
 Heteromeryx, 37, 42.  
 Heteromyidae, 70, 71.  
 Heteromys, 70, 71.  
     desmarestianus, 97.  
     fuscatus, 91, 97.  
     nigrescens, 97.  
  
 Heteromys vulcani, 91, 97.  
 Himantopus, 329, 331.  
 Hirmoneura, 285, 286.  
     brevirostris, 286.  
     clausa, 286.  
     flavipes, 286.  
     melanderi, 286.  
     occultator, 286.  
     psilotes, 286.  
     texana, 286.  
     vulcanica, 286.  
**Hirmoneurites**, 283-286.  
     **willistoni**, 283, 286.  
 Hirundo, 325.  
 Hoplomys, 88.  
     truei, 90, 91, 96.  
 Hoplophoneus (*passim*), 289-308, 312.  
     insolens, 313.  
     occidentalis, 313.  
     oreodontis, 313.  
     primævus, 313.  
     robustus, 313.  
 Hydrocorax, 330, 331.  
 Hydropsyche scudderi, 276.  
 Hylonycteris underwoodi, 111.  
 Hypertragulus, 37, 42, 249.  
 Hypisodus, 42.  
 Hypocetus, 31.  
 Hyrachyus, 245.  
 Hyracodon, 240.  
 Hystricomorpha, 72.  
 Hystriops, 71.  
  
 ICTERUS, 328, 330, 331.  
 Idris læviceps, 81.  
     nigricornis, 81.  
     **quadriscopiosus**, 80.  
 Indusia **cypridis**, 276.  
 Inia, 27.  
 Iniidae, 31.  
 Iridio bivitatus, 347.  
 Ischoptera rufescens, 73.  
 Ischyromyidae, affinities of, 64-71.  
 Ischyromys, 43, 44, 61-63, 69, 71, 241.  
     cristatus, 62, 63.  
     typus, 62, 63.  
     (**Titanotheriomys**) veterior, 63,  
     240.  
**Ischyrotomus**, 47, 50.  
 Ispida, 329, 332.

- JACANA, 329-331.  
 Jynx, 330.
- Kritosaurus**, 267-274.  
   **navajovius**, 269, 274.
- LABIDOSAURUS, 186, 190, 194, 195, 199, 214.
- Lachnomyrmex**, 263, 265.  
   **scrobiculatus**, 263.
- Lagocephalus lævigatus, 347.  
 Lagomorpha, 72.  
 Lagomyidae, 72.  
 Lagomys, 72.  
 Lagopus, 328, 331.  
 Lambdotherium, 241, 243, 246.  
 Lanius, 328, 333.  
 Larus, 329.  
 Lasiopyga, 151.  
   nemœus, 151.  
   nictitans, 151.  
 Lasiurus, 89.  
 Leistes militaris, 334.  
 Lemmus trimucronatus, 9.  
 Leporidae, 72.  
 Leptictidae, 250.  
 Leptomeryx, 39, 42, 249.  
   esculatus, 240.  
 Leptonycteris nivalis, 111.  
 Leptothorax, 261, 265.  
**Leptotomus**, 50.  
 Leptotragulus, 40, 42, 249.  
   profectus, 40, 248.  
 Lepurus, 330.  
 Lepus, 7, 72.  
   arcticus canus, 10.  
 Leucophaea maderæ, 75.  
 Lichonycteris obscurus, 91, 111.  
 Limosa, 329, 331.  
 Linaria, 326.  
 Linnæus as an ornithologist, 317.  
 Liphotiphia, 278.  
 Lithocosmus, 288.  
 Litobrochus, 275.  
 Lobotes surinamensis, 346.  
 Lorius, 326.  
 Loxia, 328.  
   curvirostra, 328.  
 Lutra annectens, 104, 105.  
 Lutra latidens, 91, 104, 105.  
 Lutreola vison energumenos, 11.  
 Lycosuchus, 207.  
   vanderrieti, 208.  
 Lynx canadensis, 10.  
 Lysorophus, 177, 214, 215.  
 Lystrosaurus, 211-213.  
   latirostris, 168.
- MACHÆRODONTINÆ, 307-309.  
 Machærodus, 290, 291, 294, 296, 298, 305, 307, 308, 314.  
 Macrochile, 281.  
 Macrochilinae, 281.  
 Macrogeomys, 88, 98.  
   cherriei, 97, 98.  
   costaricensis, 98.  
   **matagalpæ**, 91, 97.  
 Macroxus adolphei, 91.  
   pyladei, 103, 104.  
 Mainatus, 326.  
 Manacus, 328, 330, 331.  
 Manis, 13.  
   javanica, 13.  
 Manucodiata, 330.  
 Marmosa, 88.  
   cinerea nicaraguæ, 91, 92.  
   murina, 92.  
   murina mexicana, 92.  
 Marmota monax canadensis, 8.  
 Matthew, W. D., the skull of *Apternodus* and the skeleton of a new *Artiodactyl*, 33-42; on the osteology and relationship of *Paramys*, and the affinities of the *Ischyromyidae*, 43-72; the phylogeny of the *Felidae*, 289-316.
- Mazama, 89.  
   pandora, 95.  
   sartorii, 95.  
   tema, 95.  
 Megacosmus, 288.  
 Melanderella, 288.  
 Melanomys, 88.  
 Meleagris, 328, 330, 331.  
   gallopavo, 332.  
   satyra, 332.  
 Mellisuga, 325, 328, 331.  
 Meniscomys, 69.

- Meniscotherium, 243.  
 Menticirrhus americanus, 346.  
     littoralis, 347.  
 Mephitis, 89.  
     macroura vittata, 106.  
 Merganser, 330, 332.  
 Mergus, 329, 330, 332.  
     merganser, 332.  
 Merops, 330.  
 Merula, 326.  
 Mesodon, 240.  
 Mesogaulus, 69, 71.  
 Mesoplonodon, 29.  
 Mesosaurus, 204, 233.  
 Metachirus, 88.  
     fuscogriseus, 91, 93.  
     nudicaudatus colombianus, 93.  
**Metanopedias**, 79.  
     **sicarius**, 79.  
 Micronycteris megalotis mexicana, 110.  
     microtis, 90, 91, 110.  
 Microsciurus, 89.  
 Microtus, 72.  
     drummondi, 10.  
 Mimus, 326.  
 Mischoderus, 281.  
     forcipatus, 281.  
 Mobula offersi, 338, 341.  
 Molophilus comatus, 282.  
 Molossus obscurus, 114, 148.  
     rufus, 114.  
 Momotus, 329, 331.  
 Monoclonius recurvicornis, 268.  
 Mormoops megalophylla, 110.  
 Motacilla, 328, 330.  
 Mungos, 13.  
     brachyurus, 17.  
     **palawanus**, 17.  
 Muntiacus (in error for Tragulus), 13,  
     115.  
     nigricans, 13.  
 Muridæ, 72.  
 Mus, 89.  
     decumanus, 60.  
     **luteiventris**, 14.  
     musculus, 101.  
     musculus jalapæ, 101.  
 Muscicapa, 328, 330, 331, 334.  
 Mustela americana actiosa, 11.  
 Mycetes palliatus, 90, 92, 114.  
 Mylagaulidæ, 69, 71.  
 Mylagaulodon, 69, 71.  
 Mylagaulus, 69, 71.  
 Myomorpha, 72.  
 Myotis nigricans, 113.  
 Myrmecophaga, 88.  
     tridactyla centralis, 94.  
 Myrmica blanda, 262.  
     duisburgi, 265.  
 Mysops, 60, 61, 69, 71.  
 NAOSAURUS, 200, 214.  
 Narcine brasiliensis, 337.  
 Nasua, 89.  
     narica, 107.  
     narica bullata, 107.  
     narica molaris, 107.  
     phæocephala, 147.  
 Natalus stramineus, 113.  
 Necrolestes, 34.  
 Nectomys, 88.  
     dimidiatus, 91, 100.  
 Nemestrina, 285.  
**Nemestrinopsis**, 285.  
 Nemotelus, 287.  
     canadensis, 287.  
     **prisculus**, 286.  
     unicolor, 287.  
 Neoconocephalus guttatus, 76.  
     macropterus, 76.  
 Neosqualodon, 32.  
 Neotoma, 72, 89.  
     chrysomelas, 91, 99.  
**Nesomyrmex**, 259, 261.  
     **clavipilis**, 259.  
 Neuroterus, North American species  
     of, 117-136.  
 Neuroterus affinis, 131.  
     batatus, 117, 118.  
     **clarkeæ**, 132.  
     **cockerelli**, 125.  
     congregatus, 132.  
     consimilis, 119.  
     crassitelus, 136.  
     distortus, 127.  
     dubius, 130.  
     exiguissimus, 124.  
     exiguus, 129.

- Neuroterus flavipes*, 135.  
     *floccosus*, 123, 124.  
     *fragilis*, 133.  
     *gillettei*, 133.  
     *howertoni*, 122.  
     *irregularis*, 134.  
     *laurifoliae*, 130.  
     *longipennis*, 125.  
     *majalis*, 134.  
     *minutissimus*, 123.  
     *minutus*, 127.  
     *niger*, 121, 122.  
     *noxiosus*, 118.  
     *obtusilobæ*, 120.  
     *pallidipes*, 128.  
     *pallidus*, 129.  
     *pallipes*, 128.  
     ***papillosus***, 121.  
     *perminimus*, 121.  
     *politus*, 134.  
     *quercicola*, 133.  
     *rileyi*, 120.  
     *saltatorius*, 125.  
     *tectus*, 126, 130.  
     *umbilicatus*, 124.  
     *vernus*, 128.  
     *verrucarum*, 122, 123.  
     *vesiculatus*, 131.  
     *virgens*, 126.  
*Nicaragua*, mammals of, 87–115.  
 Nichols, J. T., a note on *Siphostoma pelagicum* (Osbeck), 155–157; a note on the identity of *Caranx forsteri* Cuvier & Valenciennes, 159; on two new Blennys from Florida, 161.  
*Nimravus*, 289, 290–296, 298–304, 308, **310**.  
     *brachyops*, 310.  
     *catacopis*, 311.  
     *confertus*, 310.  
     *gomphodus*, 310.  
     *intermedia*, 311.  
     *major*, 311.  
     *sectator*, 310.  
     (*Archælurus*) *debilis*, 310.  
     (*Pogonodon*) *platycopis*, 310.  
*Notiocetus*, 19.  
*Notocetus*, 19.  
*Nucifraga*, 328, 331.  
*Numenius*, 329, 331.  
*Numida*, 328, 330.  
*Nyctipithecus*, 114.  
*Nycteris*, 89.  
     *borealis mexicanus*, 113.  
     *frantzii*, 113.  
*Nyctinomus brasiliensis*, 113.  
     *gracilis*, 114.  
 OCHOTONIDÆ, 72.  
*Odocoileus costaricensis*, 95.  
     *rothschildi*, 95.  
     *rothschildi chiriquensis*, 95.  
     *truei*, 90, 91, 95.  
*Onas*, 326.  
*Onocratulus*, 330.  
*Ophichthus ocellatus*, 344.  
*Opisthacantha*, 81.  
     *mellipes*, 81.  
     *pallida*, 81.  
     *polita*, 81.  
     ***striativentris***, 81.  
*Opisthoctenodon*, 211.  
*Oreodon*, 240.  
*Oriolus*, 326, 328, 330.  
     *persicus*, 334.  
*Oryzomys*, 98.  
     *alfaroi*, 91, 98, 99.  
     *alfaroi incertus*, 91, 98, 99.  
     *costaricensis*, 100.  
     *couesi*, 98.  
     *fulvescens*, 100.  
     *magdalenæ*, 99.  
     *mollipilosus*, 99.  
     *ochraceus*, 91, 99.  
     ***richardsoni***, 91, 99.  
     *richmondi*, 98.  
     *velutina*, 99.  
     (*Melanomys*) *chrysomelas*, 98.  
     (*Oligoryzomys*) ***nicaraguæ***, 91, 100.  
*Ostralega*, 330.  
*Otocælus*, 179.  
*Ototylomys fumeus*, 91, 100.  
*Oudenodon*, 197, 200, 201, 210, 211.  
*Ovibos moschatus*, 8.  
*Oxyæna*, 289.  
 PACHYSYSTROPUS, 288.  
     ***condemnatus***, 287.  
*Paciculus*, 72.

- Palæaretomys, 70, 71.  
 Palæictops, 250, 251.  
     bicuspis, 250.  
 Palæohatteria, 196.  
 Palæolagus, 72.  
     temnodon, 240.  
 Palæonictis, 289.  
 Palamedea, 329, 331.  
 Palembangulus, 285, 286.  
     florigerus, 286.  
 Palumbus, 326.  
 Pantylus, 217.  
 Paradisea, 330.  
 Paradoxurus, 13.  
     philippinensis, 15.  
 Paramys, osteology and relationships  
     of, 43-59.  
 Paramys atwateri, 50, 51, 58.  
     bicuspis, 50, 51, 58.  
     buccatus, 50, 51, 58.  
     copei, 49-51, 58.  
     delicator, 45, 50, 52, 53, 58.  
     delicatissimus, 45, 50, 54, 58.  
     delicatus, 45, 46, 50-59.  
     excavatus, 50, 52, 58.  
     **gangeri**, 50, 51, **56-58**.  
     leptodus, 50, 56-58.  
     major, 50, 51, 58.  
     **petersoni**, 46, 50, 51, **56**, 58.  
     primævus, 50, 51, 58.  
     hians, 50, 51, 55, 56, 58.  
     quadratus, 50, 51, 58.  
     robustus, 46, 50, 54-58.  
     sciuroides, 49, 50, 56, 58.  
     superbus, 50, 55.  
     uintensis, 50, 56, 58.  
 Parasymmictus, 285.  
 Pareiasaurus, 171, 185, 197, 198, 201,  
     204, 231, 232.  
     serridens, 197.  
**Parietops multicuspis**, 250.  
 Paridris, 81.  
 Pariotichus, 177, 199, 214, 216, 217,  
     219-221, 232.  
 Parra, 329, 330, 331.  
 Parus, 328.  
     cela, 334.  
 Passer, 326-328, 331.  
 Passerculus, 326.  
 Patriofelis, 289.  
 Pavo, 326.  
 Pelecanus, 329, 330.  
 Pelosuchus, 205.  
 Pelycosauria, 220.  
 Perdix, 326, 328, 331.  
 Periplaneta australasiæ, 75.  
     brunnea, 75.  
     truncata, 75.  
 Perognathus, 70, 71.  
 Peromyscus, 9, 72.  
     maniculatus arcticus, 8, 9.  
     mexicanus saxatilis, 91, 100.  
     nicaraguæ, 91, 100.  
     (Baiomys) musculus nigrescens,<sup>r</sup> 101.  
 Peropteryx canina, 110.  
     kappleri, 147.  
 Phenacodus, 239, 240, 243.  
 Phenacomys, 7.  
 Phætalia lævigata, 73.  
 Phaëthon, 318, 329, 330.  
 Phalacrocorax, 329, 331.  
 Phalaropus, 329, 331.  
 Phasianus, 326, 328, 332.  
     phasianus, 326.  
 Phœnicircus, 333.  
 Phyllostomus hastatus, 111.  
     hastatus panamensis, 111.  
 Pica, 328, 331.  
 Picus, 325.  
 Pipra, 328, 330.  
 Planorbis florissantensis, 280.  
 Platalea, 330.  
 Platea, 330.  
 Plesiaretomys, 44, 46, 55.  
     delicatissimus, 51.  
     gervaisi, 45, 46.  
 Pleurolicus, 68, 72.  
 Plotus, 329-331.  
 Pluvialis, 329.  
 Poëbrotherium, 37, 39-41, 240.  
     eximium, 37.  
**Pœcilospondylus**, 185.  
     **francisi**, 183-188.  
 Pogonodon davisi, 313.  
 Poliosaurus, 183, 185, 186.  
 Polistes variatus, 283.  
 Polydactylus octonemus, 345.  
 Polytmus, 325, 328, 331.



- Porphyrio, 329, 331.  
 Potamogale, 33.  
 Potos, 89.  
     flavus aztecus, 106.  
 Presbytis, 151.  
     fuscus, 153.  
 Pristerognathus, 198.  
 Pristerodon, 211.  
 Proælorus, 289.  
 Procellaria, 329.  
 Proceratium, 265.  
 Procolophon, 185, 197, 201, 203, 204,  
     206, 232.  
 Procyon lotor hernandezi, 107.  
 Proechimys, 88.  
     centralis, 96.  
     cherriei, 146.  
 Proinia, 31.  
 Promerops, 328, 331.  
 Promops nasutus, 114.  
 Propappus, 201, 202.  
 Prosciurus, 51, 63, 69, 71.  
 Prosqualodon, 30, 31.  
 Protanyderus, 281.  
     vipio, 281.  
 Protitanotherium, 240.  
 Protoceras, 39, 42.  
 Protoplasa, 281.  
     fitchii, 281.  
 Protoptychus, 68, 72.  
 Protoreodon parvus, 240.  
 Protylopus, 39-42, 241, 249.  
 Pseudælorus, 290, 291, 294, 296, 298,  
     304, 308, 311.  
     intrepidus, 312.  
     quadridentatus, 312.  
 Pseudotomus, 44, 45, 55.  
     hians, 45.  
 Psittacula, 326.  
 Psittacus, 326.  
 Pteromys, 70.  
 Pteronura brasiliensis, 146.  
 Pterophryne histrio, 155.  
 Ptychognathus, 197.  
 Ptychoptera, 281, 282.  
 Ptychopteridæ, 280, 281.  
 Ptychopterinæ, 281.  
 Ptychopterula, 281.  
 Puffinus, 329, 331.  
 Putorius, 7.  
     arcticus, 11.  
     cicognanii richardsoni, 11.  
     rixosus, 11.  
     tropicalis, 105.  
     tropicalis perdus, 105.  
 Pygathrix, 151.  
 Pygoderma bilabiatum, 113.  
 Pyrrhula, 328, 331.  
 RACHYCENTRON canadus, 345.  
 Radinoderus, 281.  
     ornatissimus, 281.  
 Ramphastos, 325, 330.  
 Rangifer arcticus, 8.  
 Raphus, 329, 331.  
 Recurvirostra, 330.  
 Rehn, J. A. G., on some Orthoptera  
     from Porto Rico, Culebra and  
     Vieques Islands, 73-77.  
 Reithrodontomys, 72, 100.  
     modestus, 91, 98.  
 Rhea, 329, 331.  
 Rhinesuchus, 201, 232.  
 Rhipidomys salvini, 100.  
 Rhogeessa parvula, 113.  
     tumida, 113.  
 Rhopalodon, 205.  
 Rhynchiscus naso, 110.  
 Rhynchosaurus, 197.  
 Rhynchocephalus, 285, 286.  
     sackeni, 286.  
     subnitens, 286.  
     volaticus, 285.  
 Rogeria, 262, 265.  
 Rupicola, 328, 331.  
 Rygchopsalia, 330.  
 Rynchops, 330.  
 SACCOPTERYX bilineata centralis, 110.  
 Saimiri orstedii, 114.  
 Sapindus, 280.  
 Saurosternon, 198, 201, 203, 204.  
 Scaldicetus, 31.  
 Scaloposaurus, 207, 210.  
     constrictus, 209.  
 Scapanodon, 205, 207.  
 Scapteriscus didactylus, 76.  
 Seelio erythropoda, 82.

- Scelio guatemalensis*, 82.  
*Schistocerca aegyptia*, 76.  
*Schizodelphis crassangulum*, 26.  
*Sciuravus*, 44, 51, **59**, 69, 71.  
     *nitidus*, 60.  
*Sciuridae*, 70, 71.  
*Sciuroidea*, 69.  
*Sciuiomorpha*, 69, 71.  
*Sciuropterus*, 70.  
     *nigripes*, 14.  
     *sabrinus*, 8.  
*Sciurus*, 70, 71.  
     *æstuans gilvicularis*, 146.  
     *balloviatus*, 63, 68, 101.  
     *boothia*, 101.  
     *boothia belti*, 91, 101.  
     *chalanati*, 63, 68.  
     *deppei matagalpæ*, 91.  
     *feignouxii*, 63, 68.  
     *flammifer*, 146.  
     *griseoflavus*, 102, 103.  
     *hudsonicus*, 8.  
     *hypopyrrhus*, 90.  
     *relictus*, 63.  
     *richmondi*, 91.  
     *steeri*, 14.  
     *variegatoides*, 102, 103, 104.  
     *variegatoides adolpheii*, 91, 103.  
     *wortmani*, 63.  
     (*Baiosciurus*) *deppei matagalpæ*, 104.  
     (*Guerlinguetus*) *richmondi*, 104.  
     (*Microsciurus*) *alfari*, 104.  
     (*Prosciurus*) *vetustus*, 63.  
*Scelopax*, 329.  
*Scomberomorus maculatus*, 346.  
*Scopus*, 329, 331.  
*Seylacosaurus*, 198, 207-209.  
     *selateri*, 207.  
*Selandria*, 280.  
     **sapindi**, 279.  
*Semnopithecus*, 151.  
*Serinus*, 326.  
**Shoshonius cooperi**, 249.  
*Sigmodon hispidus griseus*, 91, 100.  
*Sigmogomphius*, 70.  
*Siphostoma pelagicum*, 155-157.  
*Smilodon (passim)*, 290-307, 315.  
*Smilodontopsis*, 316.  
*Solenodon*, 33.  
*Sorex*, 7, 89, 110.  
     *godmani*, 110.  
     *personatus*, 11.  
     *salvini*, 110.  
*Spheniscus*, 329, 331.  
*Sphenodon*, 192, 196, 203, 204, 225, 231.  
*Spermophilus*, 70, 71.  
*Sphyræna borealis*, 345.  
*Sphyrna zygaena*, 342.  
*Spilogale*, 89.  
     *angustifrons elata*, 106.  
*Squalodon*, 23, 30-32.  
     *bariensis*, 22.  
     *grateloupæ*, 32.  
     *tiedemani*, 22.  
*Squalodontidae*, 31.  
*Stathmonotus hemphillii*, 161.  
     **tekla**, 161.  
*Steganopus*, 331.  
*Stenofiber*, 68, 70, 71.  
*Stenodelphis*, 24.  
*Stenopogon breviusculus*, 283.  
*Stercorarius*, 329, 331.  
*Strix*, 324, 328.  
*Struthio*, 329.  
*Sturnira lilium*, 111.  
*Sula*, 329, 331.  
*Sus ahenobarbus*, 13.  
*Sylvilagus floridanus chiapensis*, 95.  
     *gabbi*, 95.  
     *gabbi tumacus*, 91, 96.  
     (*Tapeti*) *gabbi tumacus*, 96.  
*Symmictus*, 285.  
*Synaptomys*, 7.  
*Syndyoceras*, 42.  
*Synodus fœtens*, 344.  
*Sysphincta*, 265.  
*Systemodon*, 246.  
  
TAMANDUA, 88.  
     *longicaudata*, 146.  
     *tetradactyla chiriquensis*, 94.  
*Tamias*, 70, 71.  
*Tanagra*, 328, 330, 334, 335.  
     *albirostris*, 334.  
     *archiepiscopus*, 335.  
     *militaris*, 334.  
     *ornata*, 335.

- Tanagra tatao, 334.  
     violacea, 334, 335.  
 Tangara, 328, 330, 334.  
     tangara, 334.  
 Tanyderinae, 281.  
 Tanyderis, 281.  
     pictus, 281.  
 Tapeti, 89.  
 Tapinocephalus, 197, 201, 205, 206.  
 Tapirella, 89.  
     bairdi, 95.  
     dowi, 95.  
 Taracticus, 283.  
     **contusus**, 282.  
 Tarsius, 154.  
     bancanus, 152, 153.  
     **borneanus**, 153.  
     philippensis, 152, 154.  
     **saltator**, 152.  
     sanghirensis, 152.  
     spectrum, 152.  
 Tatu novemcinctus, 94.  
 Tatusia novemcincta, 90.  
 Taxymys, 60.  
 Tayassu angulatus, 94.  
     crusnigrum, 94, 95.  
     pecari, 95.  
     pecari ringens, 95.  
 Tayra, 89.  
     barbara barbara, 146.  
     barbara inserta, 91, 105.  
 Telerpeton, 185.  
 Telmatherium ultimum, 240.  
 Temnospondyli, 214.  
**Tersomius texensis**, 180.  
 Tetrao, 323, 328.  
 Therocephalia, 207.  
 Theropleura retroversa, 189.  
 Thescelus insiliens, 269.  
     repiens, 269.  
 Thomomys, 70, 72.  
 Thraupis, 335.  
 Thryoptera discifera, 113.  
 Tillomys, 60.  
 Tipula, 282.  
     clauda, 282.  
     evanitura, 282.  
     heilprini, 282.  
     **needhami**, 281.  
     rigens, 282.  
 Titanosuchus, 201, 205, 207.  
**Titanotheriomys**, 63.  
 Titanotherium, 240.  
     heloceras, 240, 241.  
 Todus, 329–332.  
 Torosaurus, 269.  
 Torquilla, 330.  
 Trachinotus carolinus, 345.  
 Trachodon, 270, 273.  
     (Diclionius) mirabilis, 270.  
 Trachops cirrhosus, 111.  
 Tragulus, 13, 115.  
     nigricans, 13.  
 Trematops, 214, 220.  
 Triceratops, 268, 269.  
 Trichechus, 89.  
     manatus, 94.  
 Tricyphona vitripennis, 282.  
 Trimerorhachis, 179, 180, 214.  
     **alleni**, 181.  
     conangulus, 181.  
 Tringa, 329.  
 Trochilus, 324, 325, 328.  
 Trogon, 328, 330, 331.  
 Trogontherium, 70.  
 Trucifelis, 316.  
 True, F. W., description of a skull and  
     some vertebrae of *Diachotichus van-*  
     *benedeni* from Santa Cruz, Pata-  
     gonia, 19–32.  
 Tucana, 325, 330.  
 Tupaia ferruginea palawanensis, 17.  
 Turdus, 326, 333, 334.  
 Tursiops, 22.  
 Turtur, 326.  
 Tylomys nudicaudatus, 100.  
 Tyrannosaurus, 192, 195.  
 UPUA, 328.  
 Uria, 329, 331.  
 Urocyon, 89, 107.  
     cinereoargenteus guatemalæ, 107.  
 Ursus, 3.  
     americanus, 2, 4.  
     americanus **kenaiensis**, 4–6, 115.  
     americanus **perniger**, 115.  
     americanus sornborgeri, 1–5.  
 VAMPYRODES, 112.  
     caracciola, 112.

- Vampyrops helleri, 112.  
    vittatus, 112.  
Vampyrus spectrum, 111.  
Vanellus, 329, 331.  
Varanosaurus acutirostris, 183.  
Vidua, 326.  
Viverra tungalunga, 15.  
Vomer setipennis, 345.  
Vulpes alascensis abietorum, 11.  
    lagopus innuitus, 11.  
Vultur, 324, 331.  
WHEELER, W. M., three new genera of  
    Myrmicine Ants from tropical  
    America, 259-265.  
Wind River Basin, Tertiary faunal  
    horizons of, 235-251.  
XENOTHERIUM, 33.  
Xiphidium fasciatum, 76.  
Xipholena, 333.  
ZATRACHYS, 179.  
    apicalis, 176, 179.  
    crucifer, 179.





(Continued from 4th page of cover.)

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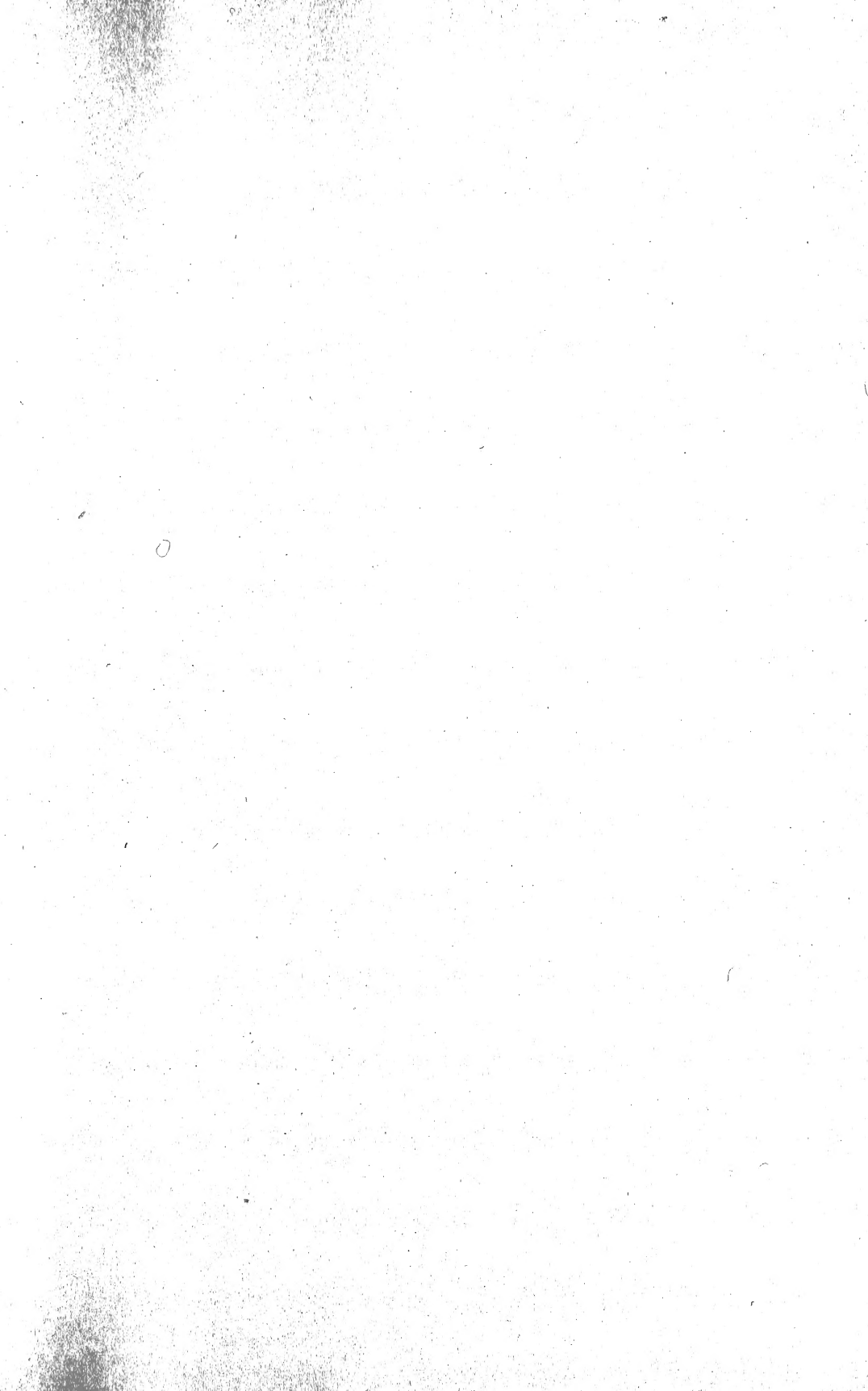
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